



National Aeronautics and  
Space Administration  
Langley Research Center

Scientific and Technical  
Information Program Office

# Scientific and Technical Aerospace Reports

# STAR

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# NASA STI Program ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program plays a key part in helping NASA maintain this important role.

The NASA STI Program provides access to the NASA STI Database, the largest collection of aeronautical and space science in the world. The STI Program is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

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- **TECHNICAL MEMORANDUM.** Scientific and technical findings that are of preliminary or specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.
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- **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.
- **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA's mission.

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The NASA STI Program is managed by the NASA STI Program Office (STIPO). STIPO is the administrative office at Langley Research Center for the NASA STI Program.

For more information about the NASA STI Program, you can:

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- Fax your question to the NASA STI Help Desk at (301) 621-0134
- Telephone the NASA STI Help Desk at (301) 621-0390
- Write to:  
NASA STI Help Desk  
NASA Center for AeroSpace Information  
7121 Standard Drive  
Hanover, MD 21076-1320

# Introduction

*Scientific and Technical Aerospace Reports (STAR)* is an online information resource listing citations and abstracts of NASA and world wide aerospace-related STI. Updated biweekly, *STAR* highlights the most recent additions to the NASA STI Database. Through this resource, the NASA STI Program provides timely access to the most current aerospace-related Research & Development (R&D) results.

*STAR* subject coverage includes all aspects of aeronautics and space research and development, supporting basic and applied research, and application, as well as aerospace aspects of Earth resources, energy development, conservation, oceanography, environmental protection, urban transportation and other topics of high national priority. The listing is arranged first by 11 broad subject divisions, then within these divisions by 76 subject categories and includes two indexes: subject and author.

*STAR* includes citations to Research & Development (R&D) results reported in:

- NASA, NASA contractor, and NASA grantee reports
- Reports issued by other U.S. Government agencies, domestic and foreign institution, universities, and private firms
- Translations
- NASA-owned patents and patent applications
- Other U.S. Government agency and foreign patents and patent applications
- Domestic and foreign dissertations and theses

## The NASA STI Program

The NASA Scientific and Technical Information (STI) Program was established to support the objectives of NASA's missions and research to advance aeronautics and space science. By sharing information, the NASA STI Program ensures that the U.S. maintains its preeminence in aerospace-related industries and education, minimizes duplication of research, and increases research productivity.

Through the NASA Center for AeroSpace Information (CASI), the NASA STI Program acquires, processes, archives, announces and disseminates both NASA's internal STI and world-wide STI. The results of 20th and 21<sup>st</sup> century aeronautics and aerospace research and development, a worldwide investment totaling billions of dollars, have been captured, organized, and stored in the NASA STI Database. New information is continually announced and made available as it is acquired, making this a dynamic and historical collection of value to business, industry, academia, federal institutions, and the general public.

The STI Program offers products and tools that allow efficient access to the wealth of information derived from global R&D efforts. In addition, customized services are available to help tailor this valuable resource to meet your specific needs.

For more information on the most up to date NASA STI, visit the STI Program's website at <http://www.sti.nasa.gov>.

# NASA STI Availability Information

## NASA Center for AeroSpace Information (CASI)

Through NASA CASI, the NASA STI Program offers many information products and services to the aerospace community and to the public, including access to a selection of full text of the NASA STI. Free registration with the program is available to NASA, U.S. Government agencies and contractors. To register, contact CASI at [help@sti.nasa.gov](mailto:help@sti.nasa.gov). Others should visit the program at [www.sti.nasa.gov](http://www.sti.nasa.gov). The 'search selected databases' button provides access to the CASI TRS – the publicly available contents of the NASA STI Database.

Each citation in *STAR* indicates a 'Source of Availability'. When CASI is indicated, the user can order this information directly from CASI using the [STI Online Order Form](#) or contact [help@sti.nasa.gov](mailto:help@sti.nasa.gov) or telephone the CASI Help Desk at 301-621-0390. Before ordering you may access price code tables for STI [documents](#) and [videos](#). When information is not available from CASI, the source of the information is indicated when known.

NASA STI is also available to the public through federal information organizations. NASA CASI disseminates publicly available NASA STI to the National Technical Information Service (NTIS) and to the Federal Depository Library Program (FDLP) through the Government Printing Office (GPO). In addition, NASA patents are available online from the U.S. Patent and Trademark Office.

## National Technical Information Service (NTIS)

The National Technical Information Service serves the American public as a central resource for unlimited, unclassified U.S. Government scientific, technical, engineering, and business related information. For more than 50 years NTIS has provided businesses, universities, and the public timely access to well over 2 million publications covering over 350 subject areas. Visit NTIS at <http://www.ntis.gov>.

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The U.S. Congress established the **Federal Depository Library Program** (FDLP) to ensure access by the American public to U.S. Government information. The program acquires and disseminates information products from all three branches of the U.S. Government to nearly 1,300 Federal depository libraries nationwide. The libraries maintain these information products as part of their existing collections and are responsible for assuring that the public has free access to the information. Locate the Federal Depository Libraries [http://www.access.gpo.gov/su\\_docs](http://www.access.gpo.gov/su_docs).

## The U.S. Patent and Trademark Office (USPTO)

The U.S. Patent and Trademark Office provides online access to full text patents and patent applications. The database includes patents back to 1976 plus some pre-1975 patents. Visit the USPTO at <http://www.uspto.gov/patft/>.

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Document citations are grouped by division and then by category, according to the NASA Scope and Coverage Category Guide.

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[Subject Term Index](#)

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# SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS

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## 01

### AERONAUTICS (GENERAL)

Includes general research topics related to manned and unmanned aircraft and the problems of flight within the Earth's atmosphere. Also includes manufacturing, maintenance, and repair of aircraft. For specific topics in aeronautics, see *categories 02 through 09*. For information related to space vehicles see *12 Astronautics*.

**20030020623** Johns Hopkins Univ., Baltimore, MD, USA

#### **Scientific and Technical Development of the Next Generation Space Telescope**

Burg, Richard; January 2003; 4 pp.; In English

Contract(s)/Grant(s): NAG5-4736; No Copyright; Avail: CASI; [A01](#), Hardcopy

The Next Generation Space Telescope (NGST) is part of the Origins program and is the key mission to discover the origins of galaxies in the Universe. It is essential that scientific requirements be translated into technical specifications at the beginning of the program and that there is technical participation by astronomers in the design and modeling of the observatory. During the active time period of this grant, the PI participated in the NGST program at GSFC by participating in the development of the Design Reference Mission, the development of the full end-to-end model of the observatory, the design trade-off based on the modeling, the Science Instrument Module definition and modeling, the study of proto-mission and test-bed development, and by participating in meetings including quarterly reviews and support of the NGST SWG. This work was documented in a series of NGST Monographs that are available on the NGST web site.

Author

*Next Generation Space Telescope Project; Spaceborne Telescopes; Astronomical Observatories; Design Analysis; Systems Engineering; Cryogenics; Optical Equipment*

## 02

### AERODYNAMICS

Includes aerodynamics of flight vehicles, test bodies, airframe components and combinations, wings, and control surfaces. Also includes aerodynamics of rotors, stators, fans, and other elements of turbomachinery. For related information see also *34 Fluid Mechanics and Thermodynamics*.

**20030020736** NASA Langley Research Center, Hampton, VA, USA

#### **Uncertainty in Computational Aerodynamics**

Luckring, J. M.; Hemsch, M. J.; Morrison, J. H.; [2003]; 15 pp.; In English; 41st AIAA Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA; Original contains color illustrations

Report No.(s): AIAA Paper 2003-0409; No Copyright; Avail: CASI; [A03](#), Hardcopy

An approach is presented to treat computational aerodynamics as a process, subject to the fundamental quality assurance principles of process control and process improvement. We consider several aspects affecting uncertainty for the computational aerodynamic process and present a set of stages to determine the level of management required to meet risk assumptions desired by the customer of the predictions.

Author

*Computational Fluid Dynamics; Aerodynamics*



## 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes all modes of communication with and between aircraft; air navigation systems (satellite and ground based); and air traffic control. For related information see also *06 Avionics and Aircraft Instrumentation*, *17 Space Communications, Spacecraft Communications, Command and Tracking*, and *32 Communications and Radar*.

**20030020778** Illinois Univ. at Urbana-Champaign, Savoy, IL, USA

#### **Effectiveness of Personal Computers to Meet Recency of Experience Requirements**

Taylor, H. L.; Talleur, D. A.; Bradshaw, G. L.; Emanuel, T. W., Jr.; Rantanen, E.; Hulin, C. L.; Lendrum, L.; February 2003; 51 pp.; In English

Contract(s)/Grant(s): DTFA-98-G-003

Report No.(s): DOT/FAA/AM-03/3; No Copyright; Avail: CASI; [A04](#), Hardcopy

The purpose of the current study was to investigate the effectiveness of PCATDs and FTDs to meet FAA recency of experience requirements for instrument flight. Two types of training devices were tested: 1) an FAA approved PCATD; and 2) a Frasca 141 FTD. An Instrument Proficiency Check (IPC) was given to all subjects in the airplane to establish a performance baseline (IPC #1). After the completion of IPC #1 in the airplane, the subjects were randomly assigned to one of four groups: the PCATD, the FTD, the aircraft or the control group with a balancing constraint so that the subjects successfully completing IPC #1 were equally distributed among the four groups. During the six-month period, each subject received two recency of experience flights of about 1.8 hours each in either the PCATD, the FTD or the aircraft; the control group received no recency training. These recency of experience flights included three instrument approaches, holding procedures, and intercepting and tracking navigation, radials and courses. After the six-month period, performance on an IPC in the airplane (IPC #2) compared pilots who received recency of experience in the training devices to a control group, which received no recency of experience. The subjects in the PCATD and FTD group were also compared to the aircraft group who received recency of experience in the airplane. This study clearly demonstrated the benefit of recency of experience training in maintaining instrument currency for instrument rated pilots. A comparison of the three training groups with the control group performance on the final instrument proficiency check indicated that the training groups performed significantly better than the control group. The study also indicated that PCATDs are effective in maintaining recency of experience for instrument rated pilots over a period of six months. The two recency of experience practice sessions resulted in significantly better performance for the PCATD group on an IPC compared to the control group, which had no practice. Practice in either the PCATD or the FTD resulted in higher pass rates compared to no practice by the control group and practice in the PCATD and the FTD was found to be at least as effective as practice in the airplane. Finally, the performance of the PCATD group was statistically indistinguishable from the FTD group. These findings present compelling evidence that the FAA should permit the use of PCATDs to maintain recency of experience for instrument pilots.

Author

*Personal Computers; Training Devices; Pilot Performance; Air Navigation*

## 05

### AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes all stages of design of aircraft and aircraft structures and systems. Also includes aircraft testing, performance, and evaluation, and aircraft and flight simulation technology. For related information see also *18 Spacecraft Design, Testing and Performance*; and *39 Structural Mechanics*. For land transportation vehicles see *85 Technology Utilization and Surface Transportation*.

**20030020729** NASA Langley Research Center, Hampton, VA, USA

#### **Imparting Desired Attributes by Optimization in Structural Design**

Sobieszczanski-Sobieski, Jaroslaw; Venter, Gerhard; [2003]; 15 pp.; In English; 44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics and Materials, 7-10 Apr. 2003, Norfolk, VA, USA; Original contains color illustrations

Report No.(s): AIAA Paper 2003-1546; No Copyright; Avail: CASI; [A03](#), Hardcopy

Commonly available optimization methods typically produce a single optimal design as a Constrained minimum of a particular objective function. However, in engineering design practice it is quite often important to explore as much of the design space as possible with respect to many attributes to find out what behaviors are possible and not possible within the initially adopted design concept. The paper shows that the very simple method of the sum of objectives is useful for such exploration. By geometrical argument it is demonstrated that if every weighting coefficient is allowed to change its magnitude and its sign then the method returns a set of designs that are all feasible, diverse in their attributes, and include the Pareto and



non-Pareto solutions, at least for convex cases. Numerical examples in the paper include a case of an aircraft wing structural box with thousands of degrees of freedom and constraints, and over 100 design variables, whose attributes are structural mass, volume, displacement, and frequency. The method is inherently suitable for parallel, coarse-grained implementation that enables exploration of the design space in the elapsed time of a single structural optimization.

Author

*Aircraft Structures; Design Analysis; Structural Design; Optimization*

**20030020731** NASA Langley Research Center, Hampton, VA, USA

**Transonic Experimental Observations of Abrupt Wing Stall on an F/A-18E Model**

McMillin, S. Naomi; Hall, Robert M.; Lamar, John E.; [2003]; 40 pp.; In English; 41st Aerospace Sciences Meeting and Exhibition, 6-9 Jan. 2003, Reno, NV., USA; Original contains color illustrations

Report No.(s): AIAA Paper 2003-0591; No Copyright; Avail: CASI; [A03](#), Hardcopy

A transonic wind tunnel test of an 8% F/A-18E model was conducted in the NASA Langley Research Center (LaRC) 16 ft Transonic Tunnel (16-ft TT) to investigate on-surface flow physics during stall. The technical approach employed focused on correlating static (or time-averaged) and unsteady wind-tunnel test data to the unsteady wing-stall events using force, moment, pressure, and pressure-sensitive-paint measurements. This paper focuses on data obtained on the pre-production configuration of the F/A-18E aircraft at Mach number of 0.90. The flow unsteadiness occurring on the wing as the wing went through the stall process was captured using the time history of balance and pressure measurements and by calculating the root mean square (RMS) for a number of instrument signals. The second step was to gather global perspectives on the pressures influencing the wing stall process. The abrupt wing stall experienced by the 8% F/A-18E Model was observed to be an unsteady event triggered by the rapid advancement of separation, which had migrated forward from the trailing edge, to the leading-edge flap hingeline over a very small increment in angle of attack. The angle of attack at which this stall occurred varied, from run to run, over an 1 degree increment. The abrupt wing stall was observed, using pressure-sensitive-paint, to occur simultaneously on both wing panels or asymmetrically. The pressure-sensitive paint data and wing-root bending moment data were essential in providing insight to the flow structures occurring over the wing and the possible asymmetry of those flow structures. A repeatability analysis conducted on eight runs of static data provided a quick and inexpensive examination of the unsteady aerodynamic characteristics of abrupt wing stall. The results of the repeatability analysis agreed extremely well with data obtained using unsteady measurement techniques. This approach could be used to identify test conditions for more complex unsteady data measurements using special instrumentation.

Author

*F-18 Aircraft; Aerodynamic Stalling; Transonic Wind Tunnels; Unsteady Aerodynamics; Wind Tunnel Tests; Aircraft Models; Wings*

**20030020800** NASA Langley Research Center, Hampton, VA, USA

**Introduction to the Abrupt Wing Stall (AWS) Program**

Hall, Robert M.; Woodson, Shawn H.; January 09, 2003; 28 pp.; In English; 41st AIAA Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA; Original contains black and white illustrations

Report No.(s): AIAA Paper 2003-0589; No Copyright; Avail: CASI; [A03](#), Hardcopy

The Abrupt Wing Stall (AWS) Program has addressed the problem of uncommanded, transonic lateral motions, such as wing drop, with experimental, computational, and simulation tools. Background to the establishment of the AWS program is given as well as program objectives. In order to understand the fundamental flow mechanisms that caused the undesirable motions for a pre-production version of the F/A-18E, steady and unsteady flow field details were gathered from dedicated transonic wind-tunnel testing and computational studies. The AWS program has also adapted a free-to-roll (FTR) wind-tunnel testing technique traditionally used for low-speed studies of lateral dynamic stability to the transonic flow regime. This FTR capability was demonstrated first in a proof-of-concept study and then applied to an assessment of four different aircraft configurations. Figures of merit for static testing and for FTR testing have been evaluated for two configurations that demonstrated wing drop susceptibility during full-scale flight conditions (the pre-production F/A-18E and the AV-8B at the extremes of its flight envelope) and two configurations that do not exhibit wing drop (the F/A-18C and the F-16C). Design insights have been obtained from aerodynamic computational studies of the four aircraft configurations and from computations quantifying the impact of the various geometric wing differences between the F/A-18C and the F/A-18E wings. Finally, the

AWS program provides guidance for assessing, in the simulator, the impact of experimentally determined lateral activity on flight characteristics before going to flight.

Author

*Aerodynamic Stalling; Computational Fluid Dynamics; Wind Tunnel Tests; F-18 Aircraft; Transonic Flow; Lateral Stability; Aircraft Design; Computerized Simulation; Flight Characteristics*

**20030020833** Old Dominion Univ., VA, USA

**Reducing Design Risk Using Robust Design Methods: A Dual Response Surface Approach**

Unal, Resit; Yeniay, Ozgur; Lepsch, Roger A., Technical Monitor; March 2003; 20 pp.; In English

Contract(s)/Grant(s): NAG1-01086; ODU Proj. 113091; No Copyright; Avail: CASI; [A03](#), Hardcopy

Space transportation system conceptual design is a multidisciplinary process containing considerable element of risk. Risk here is defined as the variability in the estimated (output) performance characteristic of interest resulting from the uncertainties in the values of several disciplinary design and/or operational parameters. Uncertainties from one discipline (and/or subsystem) may propagate to another, through linking parameters and the final system output may have a significant accumulation of risk. This variability can result in significant deviations from the expected performance. Therefore, an estimate of variability (which is called design risk in this study) together with the expected performance characteristic value (e.g. mean empty weight) is necessary for multidisciplinary optimization for a robust design. Robust design in this study is defined as a solution that minimizes variability subject to a constraint on mean performance characteristics. Even though multidisciplinary design optimization has gained wide attention and applications, the treatment of uncertainties to quantify and analyze design risk has received little attention. This research effort explores the dual response surface approach to quantify variability (risk) in critical performance characteristics (such as weight) during conceptual design.

Derived from text

*Space Transportation System; Launch Vehicles; Body-Wing Configurations; Aircraft Design; Surface Vehicles*

## 09

### RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, runways, hangars, and aircraft repair and overhaul facilities; wind tunnels, water tunnels, and shock tubes; flight simulators; and aircraft engine test stands. Also includes airport ground equipment and systems. For airport ground operations see *03 Air Transportation and Safety*. For astronomical facilities see *14 Ground Support Systems and Facilities (Space)*.

**20030020758** Aerospace Technology Application Center, USA

**Control System Upgrade for a Mass Property Measurement Facility**

Chambers, William; Hinkle, R. Kenneth, Technical Monitor; [2002]; 9 pp.; In English; 22nd IEST-NASA/ASTM/AIAA/CSA Space Simulation Conference, 21-24 October 2002; Original contains black and white illustrations

Contract(s)/Grant(s): NAS5-02034; No Copyright; Avail: CASI; [A02](#), Hardcopy

The Mass Property Measurement Facility (MPMF) at the Goddard Space Flight Center has undergone modifications to ensure the safety of Flight Payloads and the measurement facility. The MPMF has been technically updated to improve reliability and increase the accuracy of the measurements. Modifications include the replacement of outdated electronics with a computer based software control system, the addition of a secondary gas supply in case of a catastrophic failure to the gas supply and a motor controlled emergency stopping feature instead of a hard stop.

Author

*Research Facilities; Density Measurement; Control Systems Design; Systems Analysis; Failure Analysis; Systems Engineering*

## 12

### ASTRONAUTICS (GENERAL)

Includes general research topics related to space flight and manned and unmanned space vehicles, platforms or objects launched into, or assembled in, outer space; and related components and equipment. Also includes manufacturing and maintenance of such vehicles or platforms. For specific topics in astronautics see *categories 13 through 20*. For extraterrestrial exploration see *91 Lunar and Planetary Science and Exploration*.

**20030020714** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**First Results from a Hardware-in-the-Loop Demonstration of Closed-Loop Autonomous Formation Flying**

Gill, E.; Naasz, Bo; Ebinuma, T.; [2003]; 17 pp.; In English; 26th Annual AAS Guidance and Control Conference, 5-9 Feb. 2003, Breckenridge, CO, USA

Report No.(s): AAS-03-040; Copyright; Avail: CASI; [A03](#), Hardcopy

A closed-loop system for the demonstration of autonomous satellite formation flying technologies using hardware-in-the-loop has been developed. Making use of a GPS signal simulator with a dual radio frequency outlet, the system includes two GPS space receivers as well as a powerful onboard navigation processor dedicated to the GPS-based guidance, navigation, and control of a satellite formation in real-time. The closed-loop system allows realistic simulations of autonomous formation flying scenarios, enabling research in the fields of tracking and orbit control strategies for a wide range of applications. The autonomous closed-loop formation acquisition and keeping strategy is based on Lyapunov's direct control method as applied to the standard set of Keplerian elements. This approach not only assures global and asymptotic stability of the control but also maintains valuable physical insight into the applied control vectors. Furthermore, the approach can account for system uncertainties and effectively avoids a computationally expensive solution of the two point boundary problem, which renders the concept particularly attractive for implementation in onboard processors. A guidance law has been developed which strictly separates the relative from the absolute motion, thus avoiding the numerical integration of a target trajectory in the onboard processor. Moreover, upon using precise kinematic relative GPS solutions, a dynamical modeling or filtering is avoided which provides for an efficient implementation of the process on an onboard processor. A sample formation flying scenario has been created aiming at the autonomous transition of a Low Earth Orbit satellite formation from an initial along-track separation of 800 m to a target distance of 100 m. Assuming a low-thrust actuator which may be accommodated on a small satellite, a typical control accuracy of less than 5 m has been achieved which proves the applicability of autonomous formation flying techniques to formations of satellites as close as 50 m.

Author

*Formation Flying; Feedback Control; Hardware-In-The-Loop Simulation; Satellite Control; Control Systems Design; Satellite Guidance; Autonomous Navigation; Liapunov Functions*

## 13

### ASTRODYNAMICS

Includes powered and free flight trajectories; orbital and launching dynamics.

**20030020852** AI Solutions, Inc., Lanham, MD, USA

#### **Earth Shadows and the SEV Angle of MAP's Lissajous Orbit At L2**

Edery, Ariel; [2002]; 11 pp.; In English; AIAA/AAS Astrodynamics Specialist Conference, 5-8 Aug. 2002, Monterey, CA, USA

Contract(s)/Grant(s): NASS-01090; No Copyright; Avail: CASI; [A03](#), Hardcopy

The Microwave Anisotropy Probe (MAP) launched successfully on June 30, 2001 and is presently in a Lissajous orbit about the Sun-Earth libration point L2. To avoid Earth shadows at L2, the Sun-Earth-Vehicle (SEV) angle of MAP has to be greater than 0.5 deg for an extended mission of four years. An equation is derived for the SEV angle in terms of the phase angle, frequencies and amplitudes of the Lissajous. The SEV angle is shown to oscillate with a period of 90.4 days within an amplitude envelope of period 13.9 years. A range of phase angles that avoids shadows is identified. MAP'S present phase angle is within this range and will avoid shadows for approximately 5.8 years.

Author

*Microwave Anisotropy Probe; Trajectory Analysis; Orbital Mechanics; Shadows; Libration; Lissajous Figures; Stationkeeping; Spacecraft Orbits*

## 14

### GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and test chambers and simulators. Also includes extraterrestrial bases and supporting equipment. For related information see also *09 Research and Support Facilities (Air)*.

**20030020634** NASA Glenn Research Center, Cleveland, OH, USA

#### **Towers for Earth Launch**

Landis, Geoffrey A.; Lyons, Valerie J., Technical Monitor; September 2002; 15 pp.; In English; 1st Workshop on Space Elevators, 12-13 Aug. 2002, Seattle, WA., USA

Contract(s)/Grant(s): RTOP 755-A4-02; No Copyright; Avail: CASI; [A03](#), Hardcopy

This report lists some characteristics of a hypothetical 15 kilometer tower for launching spacecraft, the advantages of

launching from high altitude, and some equations pertaining to launch from a 15 kilometer tower.  
CASI  
*High Altitude; Spacecraft Launching; Towers*

**20030020716** DYNACS Engineering Co., Inc.

**Legacy and Emergence of Spaceport Technology Development at the Kennedy Space Center**

Starr, Stanley; Voska, Ned, Technical Monitor; [2003]; 8 pp.; In English; Space Congress, 29 Apr. - 1 May 2003, Cocoa Beach, FL, USA

Contract(s)/Grant(s): NAS10-98001

Report No.(s): KSC-2003-003; No Copyright; Avail: CASI; [A02](#), Hardcopy

Kennedy Space Center (KSC) has a long and successful legacy in the checkout and launch of missiles and space vehicles. These operations have become significantly more complex, and their evolution has driven the need for many technology developments. Unanticipated events have also underscored the need for a local, highly responsive technology development and testing capability. This evolution is briefly described, as well as the increasing level of technology capability at KSC. The importance of these technologies in achieving past national space goals suggests that the accomplishment of low-cost and reliable access to space will depend critically upon KSC's future success in developing spaceport technologies. This paper concludes with a description KSC's current organizational approach and major thrust areas in technology development. The first phase of our historical review focuses on the development and testing of field- deployable short- and intermediate-range ballistic missiles (1953 to 1958). These vehicles are later pressed into service as space launchers. The second phase involves the development of large space lift vehicles culminating in the Saturn V launches (1959 to 1975). The third phase addresses the development and operations of the partially reusable launch vehicle, Space Shuttle (1976 to 2000). In the current era, KSC is teaming with the U.S. Air Force (AF), industry, academia, and other partners to identify and develop Spaceport and Range Technologies necessary to achieve national space goals of lower-cost and higher-reliability space flight.

Author

*Histories; Cape Kennedy Launch Complex; Space Transportation; Technology Assessment*

## 15

### LAUNCH VEHICLES AND LAUNCH OPERATIONS

Includes all classes of launch vehicles, launch/space vehicle systems, and boosters; and launch operations. For related information see also *18 Spacecraft Design, Testing and Performance*; and *20 Spacecraft Propulsion and Power*.

**20030020715** NASA Ames Research Center, Moffett Field, CA, USA

**Intelligent Launch and Range Operations Virtual Test Bed (ILRO-VTB)**

Bardina, Jorge; Rajkumar, T.; [2003]; 8 pp.; In English; AeroSense 2003: SPIE's 17th Annual International Symposium on AeroSpace/Defense Sensing, Simulation and Controls, Orlando, FL, USA; Original contains black and white illustrations; Copyright; Avail: CASI; [A02](#), Hardcopy

Intelligent Launch and Range Operations Virtual Test Bed (ILRO-VTB) is a real-time web-based command and control, communication, and intelligent simulation environment of ground-vehicle, launch and range operation activities. ILRO-VTB consists of a variety of simulation models combined with commercial and indigenous software developments (NASA Ames). It creates a hybrid software/hardware environment suitable for testing various integrated control system components of launch and range. The dynamic interactions of the integrated simulated control systems are not well understood. Insight into such systems can only be achieved through simulation/emulation. For that reason, NASA has established a VTB where we can learn the actual control and dynamics of designs for future space programs, including testing and performance evaluation. The current implementation of the VTB simulates the operations of a sub-orbital vehicle of mission, control, ground-vehicle engineering, launch and range operations. The present development of the test bed simulates the operations of Space Shuttle Vehicle (SSV) at NASA Kennedy Space Center. The test bed supports a wide variety of shuttle missions with ancillary modeling capabilities like weather forecasting, lightning tracker, toxic gas dispersion model, debris dispersion model, telemetry, trajectory modeling, ground operations, payload models and etc. To achieve the simulations, all models are linked using Common Object Request Broker Architecture (CORBA). The test bed provides opportunities for government, universities, researchers and industries to do a real time of shuttle launch in cyber space.

Author

*Launching; Command And Control; Ground Operational Support System; Spacecraft Launching; Control Simulation*

## SPACE COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING

Includes space systems telemetry; space communications networks; astronavigation and guidance; and spacecraft radio blackout. For related information see also *04 Aircraft Communications and Navigation*; and *32 Communications and Radar*.

**20030020721** Cornell Univ., Ithaca, NY, USA

### GPS-Like Phasing Control of the Space Solar Power System Transmission Array

Psiaki, Mark L.; [2003]; 9 pp.; In English

Contract(s)/Grant(s): NAG5-11819; No Copyright; Avail: CASI; [A02](#), Hardcopy

The problem of phasing of the Space Solar Power System's transmission array has been addressed by developing a GPS-like radio navigation system. The goal of this system is to provide power transmission phasing control for each node of the array that causes the power signals to add constructively at the ground reception station. The phasing control system operates in a distributed manner, which makes it practical to implement. A leader node and two radio navigation beacons are used to control the power transmission phasing of multiple follower nodes. The necessary one-way communications to the follower nodes are implemented using the RF beacon signals. The phasing control system uses differential carrier phase relative navigation/timing techniques. A special feature of the system is an integer ambiguity resolution procedure that periodically resolves carrier phase cycle count ambiguities via encoding of pseudo-random number codes on the power transmission signals. The system is capable of achieving phasing accuracies on the order of 3 mm down to 0.4 mm depending on whether the radio navigation beacons operate in the L or C bands.

Author

*Radio Navigation; Spacecraft Power Supplies; Solar Generators; Solar Arrays; Phase Control; Power Transmission*

## SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and spacecraft control and stability characteristics. For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance*; *39 Structural Mechanics*; and *16 Space Transportation and Safety*.

**20030020805** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### Thermal-Structural Analysis of Sunshield Membranes

Johnston, John; Parrish, Keith; January 2003; 10 pp.; In English; 2003 AIAA Structures, Structural Dynamics, and Materials Conference, 7-10 Apr. 2003, Norfolk, VA, USA; Original contains black and white illustrations; No Copyright; Avail: CASI; [A02](#), Hardcopy

Future large infrared space telescopes, such as the James Webb Space Telescope (JWST), will require deployable sunshields to provide passive cooling for optics and instruments. Deployable sunshield structures for such applications typically consist of multiple thin-film membrane layers supported by deployable booms. The mechanical design of the sunshield must accommodate thermal strains due to layer-to-layer temperature differences as well as potentially large in-plane temperature gradients within individual film layers. This paper describes a thermal-structural analysis for predicting the stress state in a thin-film membrane subject to both mechanical thermal loads that could aid in the mechanical design of future sunshield structures. First the temperature field predicted by a thermal analysis is mapped to a structural finite element model, and then the structural response is predicted using a nonlinear static analysis. The structural model uses membrane elements in conjunction with a tension field material model to predict the response of the thin-film membrane layer. The tension field material model accounts for no-compression behavior associated with wrinkling and slackness. This approach was used to study the problem of a single membrane layer from the NASA reference concept for the JWST sunshield. Results from the analysis show that the membrane can experience a loss of tensile preload due to the presence of an in-plane temperature gradient representative of the cold-side layer temperature distribution predicted for the reference concept JWST.

Author

*Structural Analysis; Thermal Analysis; Spaceborne Telescopes; Fatigue (Materials); Solar Reflectors; Models; Loads (Forces)*



**20030020808** College of William and Mary, Williamsburg, VA, USA

**Predictions for Radiation Shielding Materials**

Kiefer, Richard L.; [2002]; 19 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): NCC1-327; No Copyright; Avail: CASI; [A03](#), Hardcopy

Radiation from galactic cosmic rays (GCR) and solar particle events (SPE) is a serious hazard to humans and electronic instruments during space travel, particularly on prolonged missions outside the Earth's magnetic fields. Galactic cosmic radiation (GCR) is composed of approx. 98% nucleons and approx. 2% electrons and positrons. Although cosmic ray heavy ions are 1-2% of the fluence, these energetic heavy nuclei (HZE) contribute 50% of the long-term dose. These unusually high specific ionizations pose a significant health hazard acting as carcinogens and also causing microelectronics damage inside spacecraft and high-flying aircraft. These HZE ions are of concern for radiation protection and radiation shielding technology, because gross rearrangements and mutations and deletions in DNA are expected. Calculations have shown that HZE particles have a strong preference for interaction with light nuclei. The best shield for this radiation would be liquid hydrogen, which is totally impractical. For this reason, hydrogen-containing polymers make the most effective practical shields. Shielding is required during missions in Earth orbit and possibly for frequent flying at high altitude because of the broad GCR spectrum and during a passage into deep space and LunarMars habitation because of the protracted exposure encountered on a long space mission. An additional hazard comes from solar particle events (SPEs) which are mostly energetic protons that can produce heavy ion secondaries as well as neutrons in materials. These events occur at unpredictable times and can deliver a potentially lethal dose within several hours to an unshielded human. Radiation protection for humans requires safety in short-term missions and maintaining career exposure limits within acceptable levels on future long-term exploration missions. The selection of shield materials can alter the protection of humans by an order of magnitude. If improperly selected, shielding materials can actually increase radiation damage due to penetration properties and nuclear fragmentation. Protecting space-borne microelectronics from single event upsets (SEUs) by transmitted radiation will benefit system reliability and system design cost by using optimal shield materials. Long-term missions on the surface of the Moon or Mars will require the construction of habitats to protect humans during their stay. One approach to the construction is to make structural materials from lunar or Martian regolith using a polymeric material as a binder. The hydrogen-containing polymers are considerably more effective for radiation protection than the regolith, but the combination minimizes the amount of polymer to be transported. We have made composites of simulated lunar regolith with two different polymers, LaRC-SI, a high-performance polyimide thermoset, and polyethylene, a thermoplastic.

Author

*Dosage; Exposure; Galactic Radiation; Hazards; Magnetic Fields; Polyethylenes; Polyimides; Protection; Radiation Protection; Solar Corposcular Radiation; Thermoplasticity*

**19**

**SPACECRAFT INSTRUMENTATION AND ASTRIONICS**

Includes the design, manufacture, or use of devices for the purpose of measuring, detecting, controlling, computing, recording, or processing data related to the operation of space vehicles or platforms. For related information see also *06 Avionics and Aircraft Instrumentation*; for spaceborne instruments not integral to the vehicle itself see *35 Instrumentation and Photography*; for spaceborne telescopes and other astronomical instruments see *89 Astronomy*.

**20030020676** California Univ., Lawrence Berkeley National Lab., Berkeley, CA, USA

**The Constellation-X Focal Plane Microcalorimeter Array: An NTD-Germanium Solution**

Beeman, J.; Silver, E.; Bandler, S.; Schnopper, H.; Murray, S.; Madden, N.; Landis, D.; Haller, E. E.; Barbera, M.; January 2001; 4 pp.; In English; Ninth International Workshop on Low Temperature Detectors, 22-27 Jul. 2001, Madison, WI, USA

Contract(s)/Grant(s): NAG5-5104; Copyright; Avail: CASI; [A01](#), Hardcopy

The hallmarks of Neutron Transmutation Doped (NTD) germanium cryogenic thermistors include high reliability, reproducibility, and long term stability of bulk carrier transport properties. Using micro-machined NTD Ge thermistors with integral 'flying' leads, we can now fabricate two-dimensional arrays that are built up from a series of stacked linear arrays. We believe that this modular approach of building, assembling, and perhaps replacing individual modules of detectors is essential to the successful fabrication and testing of large multi-element instruments. Details of construction are presented.

Author

*Calorimeters; Thermistors; Nuclear Reactions; Spacecraft Instruments; Carrier Transport (Solid State); Germanium; Linear Arrays; Micromachining; Focal Plane Devices*

**20030020735** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Science Goal Driven Observing and Spacecraft Autonomy**

Koratkar, Amuradha; Grosvenor, Sandy; Jones, Jeremy; Wolf, Karl; [2002]; 10 pp.; In English; SpaceOps 2002, 9-12 Oct. 2002, Houston, TX, USA; Original contains black and white illustrations; No Copyright; Avail: CASI; [A02](#), Hardcopy

Spacecraft autonomy will be an integral part of mission operations in the coming decade. While recent missions have made great strides in the ability to autonomously monitor and react to changing health and physical status of spacecraft, little progress has been made in responding quickly to science driven events. For observations of inherently variable targets and targets of opportunity, the ability to recognize early if an observation will meet the science goals of a program, and react accordingly, can have a major positive impact on the overall scientific returns of an observatory and on its operational costs. If the onboard software can reprioritize the schedule to focus on alternate targets, discard uninteresting observations prior to downloading, or download a subset of observations at a reduced resolution, the spacecraft's overall efficiency will be dramatically increased. The science goal monitoring (SGM) system is a proof-of-concept effort to address the above challenge. The SGM will have an interface to help capture higher level science goals from the scientists and translate them into a flexible observing strategy that SGM can execute and monitor. We are developing an interactive distributed system that will use on-board processing and storage combined with event-driven interfaces with ground-based processing and operations, to enable fast re-prioritization of observing schedules, and to minimize time spent on non-optimized observations.

Author

*Autonomy; Spacecraft Control; Onboard Data Processing; Spacecraft Instruments*

**20030020785** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**A Coupled Nonlinear Spacecraft Attitude Controller and Observer with an Unknown Gyro Misalignment and Gyro Bias**

Thienel, Julie; Sanner, Robert M.; [2002]; 1 pp.; In English; AAS Guidance and Control Conference, 6-9 Feb. 2003, Breckenridge, CO, USA; No Copyright; Avail: Other Sources; Abstract Only

A nonlinear control scheme for attitude control of a spacecraft is combined with a nonlinear gyro misalignment and bias observer for the case of constant gyro misalignment and bias. A persistency of excitation analysis shows the observer gyro bias estimates converge to the true bias values exponentially fast. The convergence of the misalignment estimates is also presented. Then; the resulting coupled, closed loop dynamics are proven by a Lyapunov analysis to be globally stable, with asymptotically perfect tracking. The analysis is extended to consider the effects of noise in addition to the gyro misalignment and bias. A simulation of the proposed observer-controller design is given for a rigid spacecraft tracking a specified, time-varying attitude sequence to illustrate the theoretical claims.

Author

*Spacecraft Control; Attitude Control; Nonlinearity; Gyroscopes; Misalignment; Bias*

**20030020794** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Overview of Terra**

King, Michael D.; [2002]; 1 pp.; In English; Remote Sensing of the Earth's Environment from Terra, 25-30 Aug. 2002, L'Aquila, Italy; No Copyright; Avail: Other Sources; Abstract Only

The Earth Observing System (EOS) is a space-based observing system comprised of a series of satellite sensors by which scientists can monitor the Earth, a Data and Information System (EOSDIS) enabling researchers worldwide to access the satellite data, and an interdisciplinary science research program to interpret the satellite data. During the last couple of years, seven EOS science missions were launched, representing observations of (i) total solar irradiance, (ii) Earth radiation budget, (iii) land cover & land use change, (iv) ocean processes (vector wind, sea surface temperature, ocean topography, and ocean color), (v) atmospheric processes (aerosol and cloud properties, water vapor, and temperature and moisture profiles), (vi) tropospheric chemistry, (vii) sea ice concentration, and (viii) precipitation. In succeeding years many more satellites will be launched that will contribute immeasurably to our understanding of the Earth's environment. In this lecture I will describe how scientists are using NASA's Earth science data to examine land use and natural hazards, environmental air quality, including dust storms over the world's deserts, cloud and radiation properties, sea surface temperature, and tropospheric chemistry. This lecture will describe the Terra satellite, launched in December 1999 and still operating, and each of the five sensors onboard the spacecraft. This overview will highlight the goals and objectives of this mission, and describe the contributions and unique datasets provided by each sensor. This lecture will form the background for an extensive weeklong course on Terra and all the algorithms that have been developed and implemented to process the data from this spacecraft. This lecture will include



a description of the Terra orbit, launch, data communication with the spacecraft, and data processing and archival of the data.

Author

*Earth Observing System (Eos); Satellite Instruments; Terra Spacecraft; General Overviews; Earth Sciences*

**20030020821** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**The MAP Spacecraft Angular State Estimation After Sensor Failure**

Bar-Itzhack, Itzhack Y.; Harman, Richard R.; [2003]; 22 pp.; In English; Israel Annual Conference on Aerospace Sciences, 19-20 Feb. 2003, Tel-Aviv, Israel; Copyright; Avail: CASI; [A03](#), Hardcopy

This work describes two algorithms for computing the angular rate and attitude in case of a gyro and a Star Tracker failure in the Microwave Anisotropy Probe (MAP) satellite, which was placed in the L2 parking point from where it collects data to determine the origin of the universe. The nature of the problem is described, two algorithms are suggested, an observability study is carried out and real MAP data are used to determine the merit of the algorithms. It is shown that one of the algorithms yields a good estimate of the rates but not of the attitude whereas the other algorithm yields a good estimate of the rate as well as two of the three attitude angles. The estimation of the third angle depends on the initial state estimate. There is a contradiction between this result and the outcome of the observability analysis. An explanation of this contradiction is given in the paper. Although this work treats a particular spacecraft, the conclusions have a far reaching consequence.

Author

*Microwave Anisotropy Probe; Algorithms; Angular Velocity; Attitude (Inclination); State Estimation; Spacecraft Instruments*

**20030020849** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Precision Pointing for the Laser Interferometry Space Antenna Mission**

Hyde, T. Tupper; Maghami, P. G.; [2003]; 11 pp.; In English; 2003 AAS Guidance and Control Conference, 5-9 Feb. 2003, Colorado, USA

Report No.(s): AAS-03-066; No Copyright; Avail: CASI; [A03](#), Hardcopy

The Laser Interferometer Space Antenna (LISA) mission is a planned NASA-ESA gravitational wave detector consisting of three spacecraft in heliocentric orbit. Lasers are used to measure distance fluctuations between proof masses aboard each spacecraft to the picometer level over a 5 million kilometer separation. Each spacecraft and its two laser transmit/receive telescopes must be held stable in pointing to less than 8 nanoradians per root Hertz in the frequency band 0.1-100 mHz. The pointing error is sensed in the received beam and the spacecraft attitude is controlled with a set of micro-Newton thrusters. Requirements, sensors, actuators, control design, and simulations are described.

Author

*Lisa (Observatory); Pointing Control Systems; Gravitational Waves; Laser Interferometry; Position Errors; Time Domain Analysis; Sensors; Spacecraft Control*

## 20

### SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources. For related information see also *07 Aircraft Propulsion and Power*, *28 Propellants and Fuels*, *15 Launch Vehicles and Launch Operations*, and *44 Energy Production and Conversion*.

**20030020776** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**A Comparison of Trajectory Optimization Methods for the Impulsive Minimum Fuel Rendezvous Problem**

Hughes, Steven P.; Mailhe, Laurie M.; Guzman, Jose J.; [2002]; 1 pp.; In English; 26th Annual Guidance and Control Conference, Feb. 2003, Breckenridge, CO, USA; No Copyright; Avail: Other Sources; Abstract Only

In this paper we present a comparison of optimization approaches to the minimum fuel rendezvous problem. Both indirect and direct methods are compared for a variety of test cases. The indirect approach is based on primer vector theory. The direct approaches are implemented numerically and include Sequential Quadratic Programming (SQP), Quasi-Newton, Simplex, Genetic Algorithms, and Simulated Annealing. Each method is applied to a variety of test cases including, circular to circular coplanar orbits, LEO to GEO, and orbit phasing in highly elliptic orbits. We also compare different constrained optimization routines on complex orbit rendezvous problems with complicated, highly nonlinear constraints.

Author

*Trajectory Optimization; Fuel Control; Orbital Rendezvous; Circular Orbits*

## COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

**20030020624** NASA Glenn Research Center, Cleveland, OH, USA

**Modeling of 3-D Woven Ceramic Matrix Composites**

Murthy, Pappu L. N.; Sullivan, Roy M.; Mital, Subodh K.; [2003]; 14 pp.; In English; SAMPE Symposium and Exhibition, 12-14 May 2003, Long Beach, CA, USA

Contract(s)/Grant(s): WBS 22-721-21-02; Copyright; Avail: CASI; [A03](#), Hardcopy

Three different approaches are being pursued at the NASA Glenn Research Center to predict the nanostructural behavior of three-dimensional woven ceramic matrix composites. These are: a micromechanics-based approach using W-CEMCAN (Woven Ceramic Matrix Composite Analyzer), a laminate analogy method and a structural frame approach (based on the finite element method). All three techniques are applied to predict the thermomechanical properties of a three-dimensional woven angle interlock C/SiC composite. The properties are predicted for room temperature and 1100 C and the predicted properties are compared to measurements. General observations regarding the three approaches for three-dimensional composite modeling are discussed.

Author

*Ceramic Matrix Composites; Woven Composites; Three Dimensional Composites; Nanostructure (Characteristics); Models*

**20030020631** Ohio Aerospace Inst., Brook Park, OH, USA

**Stress-Dependent Matrix Cracking in 2D Woven SiC-Fiber Reinforced Melt-Infiltrated SiC Matrix Composites**

Morscher, Gregory N.; 2003; 22 pp.; In English

Contract(s)/Grant(s): NCC3-763; RTOP 714-04-10; No Copyright; Avail: CASI; [A03](#), Hardcopy

The matrix cracking of a variety of SiC/SiC composites has been characterized for a wide range of constituent variation. These composites were fabricated by the 2-dimensional lay-up of 0/90 five-harness satin fabric consisting of Sylramic fiber tows that were then chemical vapor infiltrated (CVI) with BN, CVI with SiC, slurry infiltrated with SiC particles followed by molten infiltration of Si. The composites varied in number of plies, the number of tows per length, thickness, and the size of the tows. This resulted in composites with a fiber volume fraction in the loading direction that ranged from 0.12 to 0.20. Matrix cracking was monitored with modal acoustic emission in order to estimate the stress-dependent distribution of matrix cracks. It was found that the general matrix crack properties of this system could be fairly well characterized by assuming that no matrix cracks originated in the load-bearing fiber, interphase, chemical vapor infiltrated Sic tow-minicomposites, i.e., all matrix cracks originate in the 90 degree tow-minicomposites or the large unreinforced Sic-Si matrix regions. Also, it was determined that the larger tow size composites had a much narrower stress range for matrix cracking compared to the standard tow size composites.

Author

*Chemical Vapor Infiltration; Ceramic Matrix Composites; Matrix Materials; Cracking (Fracturing); Stress Distribution*

**20030020817** NASA Glenn Research Center, Cleveland, OH, USA

**Hoop Tensile Characterization Of SiC/SiC Cylinders Fabricated From 2D Fabric**

Verrilli, Michael J.; Yun, HeeMann; DiCarlo, James A.; Barnett, Terry R.; November 26, 2002; 7 pp.; In English; 27th Annual International Conference on Advanced Ceramics and Composites, 26-31 Jan. 2003, Cocoa Beach, FL, USA

Contract(s)/Grant(s): RTOP 714-04-15; Copyright; Avail: CASI; [A02](#), Hardcopy

Tensile stress-strain properties in the hoop direction were obtained for 100-mm diameter SiC/SiC cylinders using ring specimens machined from the cylinder ends. The cylinders were fabricated from 2D balanced fabric with several material variants, including wall thickness (6, 8, and 12 plies), Sic fiber type (Sylramic, Sylramic-iBN, Hi-Nicalon, and Hi-Nicalon S), fiber sizing type, and matrix type (full CVI Sic, and partial CVI plus melt-infiltrated SiC-Si). Fiber ply splices existed in the all the hoops. Tensile hoop measurements were made at room temperature and 1200 C using hydrostatic ring test facilities. The hoop results are compared with in-plane data measured on flat panels using same material variants, but containing no splices.

Author

*Silicon Carbides; Ring Structures; Ceramic Matrix Composites; Tensile Tests; Stress-Strain Relationships; Modulus Of Elasticity; Tensile Strength*

## INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY

Includes the analysis, synthesis, and use of inorganic and organic compounds; combustion theory; electrochemistry; and photochemistry. For related information see category 34 *Fluid Dynamics and Thermodynamics*. For astrochemistry see category 90 *Astrophysics*.

**20030020618** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Symmetric Resonance Charge Exchange Cross Section Based on Impact Parameter Treatment**

Omidvar, Kazem; Murphy, Kendrah; Atlas, Robert, Technical Monitor; January 2002; 25 pp.; In English; Copyright; Avail: CASI; [A03](#), Hardcopy

Using a two-state impact parameter approximation, a calculation has been carried out to obtain symmetric resonance charge transfer cross sections between nine ions and their parent atoms or molecules. Calculation is based on a two-dimensional numerical integration. The method is mostly suited for hydrogenic and some closed shell atoms. Good agreement has been obtained with the results of laboratory measurements for the ion-atom pairs  $H^+-H$ ,  $He^+-He$ , and  $Ar^+-Ar$ . Several approximations in a similar published calculation have been eliminated.

Author

*Resonance Charge Exchange; Cross Sections; Ions; Atoms; Molecules*

**20030020780** NASA Glenn Research Center, Cleveland, OH, USA

### **Substitution Effects and Linear Free Energy Relationships during Reduction of 4- Benzoyl-N-(4-substituted benzyl)pyridinium Cations**

Leventis, Nicholas; Zhang, Guo-Hui; Rawashdeh, Abdel-Monem M.; Sotiriou-Leventis, Chariklia; Gray, Hugh R., Technical Monitor; [2003]; 20 pp.; In English; Copyright; Avail: CASI; [A03](#), Hardcopy

In analogy to 4-(para-substituted benzoyl)-N-methylpyridinium cations (1-X's), the title species (2-X's, -X = -OCH<sub>3</sub>, -CH<sub>3</sub>, -H, -Br, -COCH<sub>3</sub>, -NO<sub>2</sub>) undergo two reversible, well-separated ( $E_{1/2}$  greater than or equal to 650 mV) one-electron reductions. The effect of substitution on the reduction potentials of 2-X's is much weaker than the effect of the same substituents on 1-X's: the Hammett rho-values are 0.80 and 0.93 for the 1st- and 2nd-e reduction of 2-X's vs. 2.3 and 3.3 for the same reductions of 1-X's, respectively. Importantly, the nitro group of 2-NO<sub>2</sub> undergoes reduction before the 2nd-e reduction of the 4-benzoylpyridinium system. These results suggest that the redox potentials of the 4-benzoylpyridinium system can be course-tuned via p-benzoyl substitution and fine-tuned via para-benzyl substitution. Introducing the recently derived substituent constant of the -NO<sub>2</sub>(sup)- group ( $\sigma_{para-NO_2(sup)} = -0.97$ ) yields an excellent correlation for the 3rd-e reduction of 2- NO<sub>2</sub> (corresponding to the reduction of the carbonyl group) with the 2nd-e reduction of the other 2-X's, and confirms the electron donating properties of -NO<sub>2</sub>(sup)-.

Author

*Free Energy; Cations; Pyridines; Electrons; Reduction (Chemistry); Benzene; Carbonyl Compounds; Linearity*

## METALS AND METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals and metallic materials; and metallurgy.

**20030020619** NASA Glenn Research Center, Cleveland, OH, USA

### **Surface Alloys and Alloy Surfaces**

Bozzolo, G.; Garces, J. E.; 2002; 3 pp.; In English

Contract(s)/Grant(s): NCC3-594; WBS 22-708-31-02; Copyright; Avail: Other Sources; Abstract Only

Surface Alloys and Alloy Surfaces is concerned with the structural, compositional, electronic and chemical properties of the surfaces of solids in which the surface layers, at least, are alloyed. Two different categories of system are covered - the surfaces of bulk alloys (alloy surfaces) and surface phases in which one or more outermost atomic layers are alloyed, while the underlying bulk involves no such intermixing (surface alloys). This book is the first to cover the important mixture of material on surface alloys and alloy surfaces. Each chapter is written by experts in different areas of these two interrelated topics, covering theory and experiment, physics and chemistry, geometrical and electronic structure. The coverage of the surface alloy topic is especially novel as it is relatively newly-recognized as quite a common phenomenon, sometimes

involving constituent elements which are immiscible in the bulk. The book is intrinsically interdisciplinary, covering both physical and chemical aspects.

Derived from text

*Metal Surfaces; Alloying; Chemical Properties; Substrates*

**20030020626** NASA Glenn Research Center, Cleveland, OH, USA

**Pt and Hf Additions to NiAl Bond Coats and Their Effect on the Lifetime of Thermal Barrier Coatings**

Nesbitt, J. A.; Gleeson, B.; Sordelet, D.; Barrett, C. A.; [2003]; 6 pp.; In English; THERMEC 2003, 7-13 Jul. 2003, Madrid, Spain

Contract(s)/Grant(s): 22-708-73-05; No Copyright; Avail: CASI; [A02](#), Hardcopy

The lifetimes of thermal barrier coatings (TBC's) with various NiAlPt(HfZr) bond coats were determined by cyclic oxidation testing at 1163 C (2125 F). The bond coats were sprayed from powders by low pressure plasma spraying onto Rene N5 superalloy substrates. Ytria stabilized zirconia (8YSZ) top coats were applied by air plasma spraying. Surprisingly, there was not a strong correlation between TBC lifetime and Pt or Hf content although Zr additions decreased lifetimes. TBC failure morphologies and bond coat microstructures were examined and are discussed with respect to the bond coat compositions.

Author

*Nickel Aluminides; Thermal Control Coatings; Heat Resistant Alloys; Hafnium; Protective Coatings; Zirconium Oxides; Platinum*

**20030020633** QSS Group, Inc., Cleveland, OH, USA

**Comparison of the Oxidation Rates of Some New Copper Alloys**

Ogbuji, Linus U. J. Thomas; Humphrey, Donald L.; September 09, 2002; 25 pp.; In English

Contract(s)/Grant(s): NAS3-98008; No Copyright; Avail: CASI; [A03](#), Hardcopy

Copper alloys were studied for oxidation resistance and mechanisms between 550 and 700 C, in reduced-oxygen environments expected in rocket engines, and their oxidation behaviors compared to that of pure copper. They included two dispersion-strengthened alloys (precipitation-strengthened and oxide-dispersion strengthened, respectively) and one solution-strengthened alloy. In all cases the main reaction was oxidation of Cu into Cu<sub>2</sub>O and CuO. The dispersion-strengthened alloys were superior to both Cu and the solution-strengthened alloy in oxidation resistance. However, factors retarding oxidation rates seemed to be different for the two dispersion-strengthened alloys.

Author

*Copper Alloys; Oxidation Resistance; Reaction Kinetics; Mechanical Properties; Aerospace Environments*

**20030020669** NASA Langley Research Center, Hampton, VA, USA

**Buckling Behavior of Long Anisotropic Plates Subjected to Fully Restrained Thermal Expansion**

Nemeth, Michael P.; February 2003; 92 pp.; In English

Contract(s)/Grant(s): 760-21-21-04

Report No.(s): NASA/TP-2003-212131; NAS 1.60:212131; L-18191; No Copyright; Avail: CASI; [A05](#), Hardcopy

An approach for synthesizing buckling results and behavior for thin, balanced and unbalanced symmetric laminates that are subjected to uniform heating or cooling and which are fully-restrained against thermal expansion or contraction is presented. This approach uses a nondimensional analysis for infinitely long, flexurally anisotropic plates that are subjected to combined mechanical loads and is based on useful nondimensional parameters. In addition, stiffness-weighted laminate thermal-expansion parameters are derived and used to determine critical temperature changes in terms of physically intuitive mechanical buckling coefficients. The effects of membrane orthotropy and anisotropy are included. Many results are presented for some common laminates that are intended to facilitate a structural designer's transition to the use of the generic buckling design curves that are presented in the paper. Several generic buckling design curves are presented that provide physical insight into buckling response and provide useful design data. Examples are presented that demonstrate the use of generic design curves. The analysis approach and generic results indicate the effects and characteristics of laminate thermal expansion, membrane orthotropy and anisotropy, and flexural orthotropy and anisotropy in a very general, unifying manner.

Author

*Anisotropic Plates; Thermal Expansion; Laminates; Dimensionless Numbers; Thermal Buckling; Structural Analysis*

**20030020853** NASA Glenn Research Center, Cleveland, OH, USA

**Atomistic Modeling of Quaternary Alloys: Ti and Cu in NiAl**

Bozzolo, Guillermo; Mosca, Hugo O.; Wilson, Allen W.; Noebe, Ronald D.; Garces, Jorge E.; August 2002; 20 pp.; In English  
Contract(s)/Grant(s): RTOP 708-31-13

Report No.(s): E-13641; Copyright; Avail: CASI; [A03](#), Hardcopy

The change in site preference in NiAl(Ti,Cu) alloys with concentration is examined experimentally via ALCHEMI and theoretically using the Bozzolo-Ferrante-Smith (BFS) method for alloys. Results for the site occupancy of Ti and Cu additions as a function of concentration are determined experimentally for five alloys. These results are reproduced with large-scale BFS-based Monte Carlo atomistic simulations. The original set of five alloys is extended to 25 concentrations, which are modeled by means of the BFS method for alloys, showing in more detail the compositional range over which major changes in behavior occur. A simple but powerful approach based on the definition of atomic local environments also is introduced to describe energetically the interactions between the various elements and therefore to explain the observed behavior.

Author

*Mathematical Models; Quaternary Alloys; Intermetallics; Atomic Structure; Nickel Aluminides; Titanium Alloys; Copper Alloys; Monte Carlo Method*

## 28

### PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels. For nuclear fuels see 73 *Nuclear Physics*. For related information see also 07 *Aircraft Propulsion and Power*; 20 *Spacecraft Propulsion and Power*; and 44 *Energy Production and Conversion*.

**20030020732** Massachusetts Inst. of Tech., Cambridge, MA, USA

**Microfabricated Liquid Rocket Motors**

Epstein, Alan H.; Joppin, C.; Kerrebrock, J. L.; Schneider, Steven J., Technical Monitor; March 2003; 202 pp.; In English  
Contract(s)/Grant(s): NAG3-2506; No Copyright; Avail: CASI; [A10](#), Hardcopy

Under NASA Glenn Research Center sponsorship, MIT has developed the concept of micromachined, bipropellant, liquid rocket engines. This is potentially a breakthrough technology changing the cost-performance tradeoffs for small propulsion systems, enabling new applications, and redefining the meaning of the term low-cost-access-to-space. With this NASA support, a liquid-cooled, gaseous propellant version of the thrust chamber and nozzle was designed, built, and tested as a first step. DARPA is currently funding MIT to demonstrate turbopumps and controls. The work performed herein was the second year of a proposed three-year effort to develop the technology and demonstrate very high power density, regeneratively cooled, liquid bipropellant rocket engine thrust chamber and nozzles. When combined with the DARPA turbopumps and controls, this work would enable the design and demonstration of a complete rocket propulsion system. The original MIT-NASA concept used liquid oxygen-ethanol propellants. The military applications important to DARPA imply that storable liquid propellants are needed. Thus, MIT examined various storable propellant combinations including N<sub>2</sub>O<sub>4</sub> and hydrazine, and H<sub>2</sub>O<sub>2</sub> and various hydrocarbons. The latter are preferred since they do not have the toxicity of N<sub>2</sub>O<sub>4</sub> and hydrazine. In reflection of the newfound interest in H<sub>2</sub>O<sub>2</sub>, it is once again in production and available commercially. A critical issue for the microrocket engine concept is cooling of the walls in a regenerative design. This is even more important at microscale than for large engines due to cube-square scaling considerations. Furthermore, the coolant behavior of rocket propellants has not been characterized at microscale. Therefore, MIT designed and constructed an apparatus expressly for this purpose. The report details measurements of two candidate microrocket fuels, JP-7 and JP-10.

Author

*Liquid Propellant Rocket Engines; Micromachining; Microrocket Engines; Fabrication; Microelectromechanical Systems; Storable Propellants*

**20030020734** Defence Science and Technology Organisation, Edinburgh, Australia

**Analysis of a Generic Warhead, Part 1, Experimental and Computational Assessment of Free Field Overpressure**

Anderson, J. G.; Katselis, G.; Caputo, C.; July 2002; 47 pp.; In English

Report No.(s): DSTO-TR-1313-Pt-1; DODA-AR-012-345-Pt-1; Copyright; Avail: Other Sources

Experimental and numerical results are presented for the free field blast generated by a 7.8 kg cylindrical charge of Composition B high explosive. In the experiments, overpressure and shock front time of arrival measurements have been recorded. Overpressure measurements in the far field provide pressure histories at discrete locations. Peak overpressure in the



near field is calculated from time of arrival measurements. In addition, the numerical model was used to generate overpressure histories and two-dimensional contour plots of the blast wave.

Author

*Detonation Waves; Mathematical Models; Overpressure; Shock Waves; Warheads; Blast Loads; Explosives*

## 31

### ENGINEERING (GENERAL)

Includes general research topics related to engineering and applied physics, and particular areas of vacuum technology, industrial engineering, cryogenics, and fire prevention. For specific topics in engineering see *categories 32 through 39*.

**20030020628** NASA Kennedy Space Center, Cocoa Beach, FL, USA

#### **Thermal Performance Testing Of Cryogenic Piping Systems**

Fesmire, J. E.; Augustynowicz, S. D.; Nagy, Z. F.; February 24, 2003; 8 pp.; In English; 21st International Congress of Refrigeration, 17-22 Aug. 2003, Washington, DC., USA; Original contains black and white illustrations

Report No.(s): KSC-2003-026; Copyright; Avail: CASI; [A02](#), Hardcopy

Thermal performance measurement of piping systems under actual field conditions is important for space launch development and commercial industry. Knowledge of the true insulating effectiveness is needed in system design, development, and research activities. A new 18-meter-long test apparatus for cryogenic pipelines has been developed. Three different pipelines, rigid or flexible, can be tested simultaneously. Critical factors in heat leak measurements include eliminating heat transfer at end connections and obtaining proper liquid saturation condition. Effects due to variations in the external ambient conditions like wind, humidity, and solar radiation must be minimized. The static method of liquid nitrogen evaporation has been demonstrated, but the apparatus can be adapted for dynamic testing with cryogenics, chilled water, or other working fluids. This technology is suited for the development of an industry standard test apparatus and method. Examples of the heat transfer data from testing commercially available pipelines are given. Prototype pipelines are currently being tested and evaluated at the Cryogenics Test Laboratory of NASA Kennedy Space Center.

Author

*Dynamic Tests; Performance Tests; Pipelines; Temperature Effects; Cryogenics; Test Equipment*

## 32

### COMMUNICATIONS AND RADAR

Includes radar; radio, wire, and optical communications; land and global communications; communications theory. For related information see also 04 Aircraft Communications and Navigation; and 17 *Space Communications, Spacecraft Communications, Command and Tracking*; for search and rescue, see 03 *Air Transportation and Safety*, and 16 *Space Transportation and Safety*.

**20030020843** NASA Glenn Research Center, Cleveland, OH, USA

#### **Transmission of RF Signals Over Optical Fiber for Avionics Applications**

Slaveski, Filip; Sluss, James, Jr.; Atiquzzaman, Mohammed; Hug, Nguyen; Ngo, Duc; [2002]; 8 pp.; In English; The 21st Digital Avionics Systems Conference (DASC), 27-31 October 2002, Irvine, CA, USA; Original contains black and white illustrations

Contract(s)/Grant(s): NCC3-903; RTOP 727-01-10

Report No.(s): E-13603; Paper-277; No Copyright; Avail: CASI; [A02](#), Hardcopy

During flight, aircraft avionics transmit and receive RF signals to/from antennas over coaxial cables. As the density and complexity of onboard avionics increases, the electromagnetic interference (EM) environment degrades proportionately, leading to decreasing signal-to-noise ratios (SNRs) and potential safety concerns. The coaxial cables are inherently lossy, limiting the RF signal bandwidth while adding considerable weight. To overcome these limitations, we have investigated a fiber optic communications link for aircraft that utilizes wavelength division multiplexing (WDM) to support the simultaneous transmission of multiple signals (including RF) over a single optical fiber. Optical fiber has many advantages over coaxial cable, particularly lower loss, greater bandwidth, and immunity to EM. In this paper, we demonstrate that WDM can be successfully used to transmit multiple RF signals over a single optical fiber with no appreciable signal degradation. We investigate the transmission of FM and AM analog modulated signals, as well as FSK digital modulated signals, over a fiber optic link (FOL) employing WDM. We present measurements of power loss, delay, SNR, carrier-to-noise ratio (CNR), total

harmonic distortion (THD), and bit error rate (BER). Our experimental results indicate that WDM is a fiber optic technology suitable for avionics applications.

Author

*Avionics; Optical Fibers; Radio Frequencies; Optoelectronic Devices; Signal Transmission*

### 33

#### ELECTRONICS AND ELECTRICAL ENGINEERING

Includes development, performance, and maintainability of electrical/electronic devices and components; related test equipment; and microelectronics and integrated circuitry. for related information see also *60 Computer Operations and Hardware*; and *76 Solid-State Physics*. For communications equipment and devices see *32 Communications and Radar*.

**20030020620** NASA Glenn Research Center, Cleveland, OH, USA

##### **Coupling Between CPW and Slotline Modes in Finite Ground CPW with Unequal Ground Plane Widths**

Ponchak, George E.; Papapolymerou, John; Williams, W. D., Technical Monitor; Tentzeris, Emmanouil M.; December 04, 2002; 10 pp.; In English

Contract(s)/Grant(s): WBS 22-755-08-03; Copyright; Avail: CASI; [A02](#), Hardcopy

The coupling between the desired CPW mode and the unwanted, slotline, mode is presented for finite ground coplanar waveguides with unequal ground plane widths. Measurements, quasi-static conformal mapping, and Method of Moment analysis are performed to determine the dependence of the slotline mode excitation on the physical dimensions of the FGC line and on the frequency range of operation. Introduction: Finite ground coplanar waveguide (FGC) is often used in low cost Monolithic Microwave Integrated Circuits (MMICs) because of its many advantages over microstrip and conventional CoPlanar Waveguide (CPW). It is uniplanar, which facilitates easy connection of series and shunt elements without via holes, supports a low loss, quasi-TEM mode over a wide frequency band, and since the ground planes are electrically and physically narrow, typically less than  $\lambda/5$  wide where  $\lambda$  is the guided wavelength, they reduce the circuit size and the influence of higher order modes. However, they still support the parasitic slotline mode that plagues all CPW transmission lines.

Derived from text

*Coupling; Waveguides; Planar Structures; Integrated Circuits*

**20030020751** NASA Glenn Research Center, Cleveland, OH, USA

##### **Effect of Branching on Rod-Coil Polyimides as Membrane Materials for Lithium Polymer Batteries**

Meador, Mary Ann B.; Cubon, Valerie A.; Scheiman, Daniel A.; Bennett, William R.; [2003]; 11 pp.; In English; Original contains black and white illustrations; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper describes a series of rod-coil block co-polymers that produce easy to fabricate, dimensionally stable films with good ionic conductivity down to room temperature for use as electrolytes for lithium polymer batteries. The polymers consist of short, rigid rod polyimide segments, alternating with flexible, polyalkylene oxide coil segments. The highly incompatible rods and coils should phase separate, especially in the presence of lithium ions. The coil phase would allow for conduction of lithium ions, while the rigid rod phase would provide a high degree of dimensional stability. An optimization study was carried out to study the effect of four variables (degree of branching, formulated molecular weight, polymerization solvent and lithium salt concentration) on ionic conductivity, glass transition temperature and dimensional stability in this system.

Author

*Lithium Batteries; Polyimides; Electrolytes; Polymerization; Ion Currents*

**20030020764** NASA Glenn Research Center, Cleveland, OH, USA

##### **Experimental Analysis of Reduced-Sized Coplanar Waveguide Transmission Lines**

Ponchak, George E.; January 2002; 4 pp.; In English; IEEE MTT-S International Microwave Symposium, 8-13 Jun. 2003, Philadelphia, PA, USA

Contract(s)/Grant(s): RTOP 322-20-03; No Copyright; Avail: CASI; [A01](#), Hardcopy

An experimental investigation of the use of capacitive loading of coplanar waveguides to reduce their line length and, thus the size, of monolithic microwave integrated circuits is presented. The reduced sized coplanar waveguides are compared to unloaded transmission lines and to lumped element transmission line segments. The phase bandwidth, defined by 2 percent error in  $S_{21}$ , and the return loss bandwidth, defined by a return loss greater than 15 dB, of coplanar waveguides reduced



from 0 to 90 percent are compared, and the insertion loss as a function of the size reduction is presented.

Author

*Transmission Lines; Waveguides; Capacitance; Integrated Circuits; Microwave Circuits; Planar Structures*

## 34

### FLUID MECHANICS AND THERMODYNAMICS

Includes fluid dynamics and kinematics and all forms of heat transfer; boundary layer flow; hydrodynamics; hydraulics; fluidics; mass transfer and ablation cooling. For related information see also *02 Aerodynamics*.

**20030020636** NASA Dryden Flight Research Center, Edwards, CA, USA

#### **In-Flight Capability for Evaluating Skin-Friction Gages and Other Near-Wall Flow Sensors**

Bui, Trong T.; Pipitone, Brett J.; Krake, Keith L.; Richwine, Dave, Technical Monitor; February 2003; 34 pp.; In English; 41st AIAA Aerospace Sciences Meeting and Exhibit, 6-9 Jan. 2003, Reno, NV, USA; Original contains black and white illustrations

Contract(s)/Grant(s): RTOP 710-55-04-RR

Report No.(s): NASA/TM-2003-210738; H-2518; NAS 1.15:210738; AIAA Paper 2003-0741; No Copyright; Avail: CASI; [A03](#), Hardcopy

An 8-in.-square boundary-layer sensor panel has been developed for in-flight evaluation of skin-friction gages and other near-wall flow sensors on the NASA Dryden Flight Research Center F-15B/Flight Test Fixture (FTF). Instrumentation on the sensor panel includes a boundary-layer rake, temperature sensors, static pressure taps, and a Preston tube. Space is also available for skin-friction gages or other near-wall flow sensors. Pretest analysis of previous F-15B/FTF flight data has identified flight conditions suitable for evaluating skin-friction gages. At subsonic Mach numbers, the boundary layer over the sensor panel closely approximates the two-dimensional (2D), law-of-the-wall turbulent boundary layer, and skin-friction estimates from the Preston tube and the rake (using the Clauser plot method) can be used to evaluate skin-friction gages. At supersonic Mach numbers, the boundary layer over the sensor panel becomes complex, and other means of measuring skin friction are needed to evaluate the accuracy of new skin-friction gages. Results from the flight test of a new rubber-damped skin-friction gage confirm that at subsonic Mach numbers, nearly 2D, law-of-the-wall turbulent boundary layers exist over the sensor panel. Sensor panel data also show that this new skin-friction gage prototype does not work in flight.

Author

*Skin Friction; Sensors; In-Flight Monitoring; Wall Flow; Flight Test Instruments; Friction Measurement; Pressure Distribution*

**20030020698** NASA Glenn Research Center, Cleveland, OH, USA

#### **A Thermodynamic Theory Of Solid Viscoelasticity. Part 1: Linear Viscoelasticity.**

Freed, Alan D.; Leonov, Arkady I.; Journal of the Mechanics and Physics of Solids; July 03, 2002; 16 pp.; In English

Contract(s)/Grant(s): NCC3-752; RTOP 708-24-13; Copyright; Avail: CASI; [A03](#), Hardcopy

The present series of three consecutive papers develops a general theory for linear and finite solid viscoelasticity. Because the most important object for nonlinear studies are rubber-like materials, the general approach is specified in a form convenient for solving problems important for many industries that involve rubber-like materials. General linear and nonlinear theories for non-isothermal deformations of viscoelastic solids are developed based on the quasi-linear approach of non-equilibrium thermodynamics. In this, the first paper of the series, we analyze non-isothermal linear viscoelasticity, which is applicable in a range of small strains not only to all synthetic polymers and bio-polymers but also to some non-polymeric materials. Although the linear case seems to be well developed, there still are some reasons to implement a thermodynamic derivation of constitutive equations for solid-like, non-isothermal, linear viscoelasticity. The most important is the thermodynamic modeling of thermo-rheological complexity, i.e. different temperature dependences of relaxation parameters in various parts of relaxation spectrum. A special structure of interaction matrices is established for different physical mechanisms contributed to the normal relaxation modes. This structure seems to be in accord with observations, and creates a simple mathematical framework for both continuum and molecular theories of the thermo-rheological complex relaxation phenomena. Finally, a unified approach is briefly discussed that, in principle, allows combining both the long time (discrete) and short time (continuous) descriptions of relaxation behaviors for polymers in the rubbery and glassy regions.

Author

*Constitutive Equations; Deformation; Glass; Linearity; Viscoelasticity*

**20030020723** NASA Glenn Research Center, Cleveland, OH, USA

**Caustics and Caustic-interference in Measurements of Contact Angle and Flow Visualization through Laser Shadowgraphy**

Chao, David F.; Zhang, Neng-Li; [2002]; 6 pp.; In English; Eurotherm 71 on 2 Visualization Imaging and Data Analysis in Convective Heat Transfer, 28-30 Oct. 2002, France

Contract(s)/Grant(s): NCC3-620; RTOP 101-13-0B; No Copyright; Avail: CASI; [A02](#), Hardcopy

As one of the basic elements of the shadowgraphy optical system, the image of the far field from the droplet implicates plentiful information on the droplet profile. An analysis of caustics by wave theory shows that a droplet with a cylindrically symmetric Gaussian-hill-type profile produces a circular directional caustic in far field, which arises from the singularities (inflection line on the surface). The sessile liquid droplets, which profiles are restricted by surface tension, usually have a 'protruding foot' where the surface inflects. Simple geometrical optics indicates that the circular caustic stemming from the surface inflection at the protruding-foot takes the shape of the outmost ring on the image of the far field. It is the diameter of the outmost ring that is used as one of the key parameters in the measurements of contact angle through the laser shadowgraphic method. Different surface characteristics of the droplets produce different type of caustics, and therefore, the shape of the caustics can be used to determine the surface property of the sessile droplets. The present paper describes the measurement method of contact angle using the circular caustics and the estimation of the protruding-foot height through the caustic interference.

Author

*Drops (Liquids); Interfacial Tension; Shadowgraph Photography; Flow Visualization; Alkalies; Angles (Geometry); Wavelet Analysis; Phase Transformations*

**20030020759** NorthWest Research Associates, Inc., Bellevue, WA, USA

**MHD Instability and Turbulence in the Tachocline**

Werne, Joe; Wagner, William J., Technical Monitor; March 25, 2003; 13 pp.; In English

Contract(s)/Grant(s): NASW-99026

Report No.(s): NWRA-CoRA-03-P258; NASA-9026-Final; No Copyright; Avail: CASI; [A03](#), Hardcopy

The focus of this project was to study the physical processes that govern tachocline dynamics and structure. Specific features explored included stratification, shear, waves, and toroidal and poloidal background fields. In order to address recent theoretical work on anisotropic mixing and dynamics in the tachocline, we were particularly interested in such anisotropic mixing for the specific tachocline processes studied. Transition to turbulence often shapes the largest-scale features that appear spontaneously in a flow during the development of turbulence. The resulting large-scale straining field can control the subsequent dynamics; therefore, anticipation of the large-scale straining field that results for individual realizations of the transition to turbulence can be important for subsequent dynamics, flow morphology, and transport characteristics. As a result, we paid particular attention to the development of turbulence in the stratified and sheared environment of the tachocline. This is complicated by the fact that the linear stability of sheared MHD flows is non-self-adjoint, implying that normal asymptotic linear stability theory may not be relevant.

Author

*Magnetohydrodynamic Flow; Magnetohydrodynamic Stability; Turbulence; Toroidal Plasmas; Magnetic Fields; Dynamic Structural Analysis; Stratification*

**20030020783** NASA Glenn Research Center, Cleveland, OH, USA

**A Thermodynamic Theory of Solid Viscoelasticity, Part II.: Nonlinear Thermo-viscoelasticity**

Freed, Alan D.; Leonov, Arkady I.; Gray, Hugh R., Technical Monitor; July 03, 2002; 20 pp.; In English

Contract(s)/Grant(s): NCC3-752

Report No.(s): Rept-3/PT2; No Copyright; Avail: CASI; [A03](#), Hardcopy

This paper, second in the series of three papers, develops a general, nonlinear, non-isothermal, compressible theory for finite rubber viscoelasticity and specifies it in a form convenient for solving problems important to the rubber, tire, automobile, and air-space industries, among others. Based on the quasi-linear approach of non-equilibrium thermodynamics, a general nonlinear theory of differential type has been developed for arbitrary non-isothermal deformations of viscoelastic solids. In this theory, the constitutive equations were presented as the sum of a rubber elastic (equilibrium) and a liquid type viscoelastic (non-equilibrium) terms. These equations have then been simplified using several modeling and simplicity arguments.

Author

*Viscoelasticity; Thermodynamic Equilibrium; Nonlinearity*

**20030020829** Colorado Univ., Boulder, CO, USA

**Thermocapillary-Induced Phase Separation with Coalescence**

Davis, Robert H.; [2003]; 9 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): NAG3-2116; No Copyright; Avail: CASI; [A02](#), Hardcopy

Research has been undertaken on interactions of two or more deformable drops (or bubbles) in a viscous fluid and subject to a temperature, gravitational, or flow field. An asymptotic theory for nearly spherical drops shows that small deformations reduce the coalescence and phase separation rates. Boundary-integral simulations for large deformations show that bubbles experience alignment and enhanced coalescence, whereas more viscous drops may break as a result of hydrodynamic interactions. Experiments for buoyancy motion confirm these observations. Simulations of the sedimentation of many drops show clustering phenomena due to deformations, which lead to enhanced phase separation rates, and simulations of sheared emulsions show that deformations cause a reduction in the effective viscosity.

Author

*Thermocapillary Migration; Phase Separation (Materials); Coalescing; Drops (Liquids); Bubbles*

**35**

**INSTRUMENTATION AND PHOTOGRAPHY**

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography. For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Avionics and Aircraft Instrumentation*; and *19 Spacecraft Instrumentation and Astrionics*.

**20030020727** Colorado Univ., Boulder, CO, USA

**Superconducting Mixers for Far-Infrared Spectroscopy**

Betz, A. L.; Boreiko, R. T.; Grossman, E. R.; Reintsema, C. D.; Ono, R. H.; Gerecht, E.; January 2002; 10 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): NAG5-8538; No Copyright; Avail: CASI; [A02](#), Hardcopy

The goal of this project was to fabricate and test planar arrays of superconducting mixers for the 2-6 THz band. The technology is intended for multi-beam receivers aboard Explorer-class missions and the SOFIA Airborne Observatory. The mixer technology is the superconducting transition-edge microbolometer, which is more commonly known as the Hot-Electron micro-Bolometer (HEB). As originally proposed, two superconducting technologies were to be developed: (1) low-Tc niobium HEBs which could approach quantum-noise-limited sensitivities but require cooling to 2- 4 K, and (2) high-Tc YBCO HEBs with sensitivities 10 times worse but with a relaxed cooling requirement of 30-60 K. The low-Tc devices would be best for astronomy applications on SOFIA, whereas the high-Tc devices would be more suitable for planetary missions using systems without stored cryogenes. The work plan called for planar micro-fabrication and initial testing of HEB devices at the NIST Boulder clean-room facility. Subsequent assembly and RF testing of selected devices would be done at the CASA laboratory at U. Colorado. Approximately 1-year after work began on this project, Dr. Eyal Gerecht joined the NIST group, and assumed day-to-day responsibility for Nb-HEB development at NIST outside of micro-fabrication. The YBCO-HEB work was to be guided by Dr. Ron Ono, who was the NIST expert in YBCO technology. Unfortunately, recurrent health problems limited the time Ron could devote to the project in its first year. These problems became aggravated in early 2001, and sadly led to Ron's death in October, 2001. His loss was not only a blow to his friends and associates at NIST, but was mounted by the US superconductivity community at large. With his passing, work on high-Tc HEBs ceased at NIST. There was no one to replace him or his expertise. Our work subsequently shifted solely to Nb-HEB devices. In the sections which follow, our progress in the development of diffusion-cooled Nb-HEB mixers is detailed. To simplify the terminology, these devices will subsequently be called DHEB mixers to distinguish them from phonon-cooled devices (PHEBs).

Author

*Fabrication; Performance Tests; Planar Structures; Arrays; Far Infrared Radiation; Spectroscopy*

**20030020746** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**A Focal Plane Stellar X-Ray Polarimeter for SXG**

Christensen, Larry, Technical Monitor; Silver, Eric; February 2003; 2 pp.; In English

Contract(s)/Grant(s): NAG5-6939; No Copyright; Avail: CASI; [A01](#), Hardcopy

This report covers progress on a grant for the Stellar X-Ray Polarimeter (SXR). SXR is the only X-ray polarimeter designed to view astrophysical sources that is currently scheduled to be flown. The SXR is one of eight astronomical X-ray

instruments that intended to be flown at the focal plane of the two SODART large-area metal-foil grazing-incidence X-ray telescopes on the Russian Spectrum-Roentgen-Gamma (SRG) mission.

Derived from text

*Grazing Incidence Telescopes; Polarimeters; Focal Plane Devices*

**20030020750** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Microcalorimeters for High Resolution X-Ray Spectroscopy of Laboratory and Astrophysical Plasmas**

Silver, E.; Flowers, Bobby J., Technical Monitor; February 2003; 3 pp.; In English

Contract(s)/Grant(s): NAG5-5104; No Copyright; Avail: CASI; [A01](#), Hardcopy

The proposal has three major objectives. The first focuses on advanced neutron-transmutation-doped (NTD)-based microcalorimeter development. Our goal is to develop an array of microcalorimeters with sub- 5 eV energy resolution that can operate with pile-up-free throughput of at least 100 Hz per pixel. The second objective is to establish our microcalorimeter as an essential x-ray diagnostic for laboratory astrophysics studies. We propose to develop a dedicated microcalorimeter spectrometer for the EBIT (electron beam ion trap). This instrument will incorporate the latest detector and cryogenic technology that we have available. The third objective is to investigate innovative ideas related to possible flight opportunities. These include compact, long lived cryo-systems, ultra-low temperature cold stages, low mass and low power electronics, and novel assemblies of thin windows with high x-ray transmission.

Author

*Calorimeters; Microinstrumentation; X Ray Spectroscopy; Space Plasmas; Cryogenic Equipment*

**20030020753** American Telephone and Telegraph Co., Washington, DC, USA

**Preliminary Planar Formation-Flight Dynamics Near Sun-Earth L2 Point**

Segerman, Alan M.; Zedd, Michael F.; Bauer, Frank H., Technical Monitor; December 20, 2002; 20 pp.; In English; 2003 AAS/AIAA Space Flight Mechanics Meeting, 9-13 Feb. 2003, Ponce, Puerto Rico

Contract(s)/Grant(s): NASA Order S-65018-Y

Report No.(s): AAS-03-133; No Copyright; Avail: CASI; [A03](#), Hardcopy

A few space agencies are planning missions to the vicinity of the Sun-Earth L(sub 2) point, some involving a distributed space system of telescope spacecraft, configured in a plane about a hub. An improved understanding is developed of the relative motion of such objects in formation flight. The telescope equations of motion are written relative to the hub, in terms of the hub s distance from L(sub 2), and an analytical solution is developed, useful for performing orbit control analysis. A halo telescope orbit is investigated, with initial conditions selected to avoid resonance excitation. An example case of the resulting solution is presented.

Author

*Equations Of Motion; Spaceborne Telescopes; Numerical Analysis; Orbit Calculation*

**20030020823** NASA Kennedy Space Center, Cocoa Beach, FL, USA

**Interferometer for Space Station Windows**

Hall, Gregory; [2003]; 8 pp.; In English; Space Congress, 29 Apr. - 1 May 2003, Cape Canaveral, FL, USA

Report No.(s): KSC-2002-009; No Copyright; Avail: CASI; [A02](#), Hardcopy

Inspection of space station windows for micrometeorite damage would be a difficult task insitu using current inspection techniques. Commercially available optical profilometers and inspection systems are relatively large, about the size of a desktop computer tower, and require a stable platform to inspect the test object. Also, many devices currently available are designed for a laboratory or controlled environments requiring external computer control. This paper presents an approach using a highly developed optical interferometer to inspect the windows from inside the space station itself using a self-contained hand held device. The interferometer would be capable as a minimum of detecting damage as small as one ten thousands of an inch in diameter and depth while interrogating a relatively large area. The current developmental state of this device is still in the proof of concept stage. The background section of this paper will discuss the current state of the art of profilometers as well as the desired configuration of the self-contained, hand held device. Then, a discussion of the developments and findings that will allow the configuration change with suggested approaches appearing in the proof of concept section.

Author

*Windows (Apertures); Profilometers; Inspection; Interferometers; Space Station Freedom; Meteoritic Damage*

**20030020839** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**X-Ray and Gamma-Ray Astronomy with NTD Germanium-based Microcalorimeters**

Silver, E.; Bandler, S.; Schnopper, H.; Murray, S.; Madden, N.; Landis, D.; Goulding, F.; Beeman, J.; Haller, E. E.; Barbera, M.; [2003]; 4 pp.; In English; Ninth International Workshop on Low Temperature Detectors, 22-27 Jul. 2001, Madison, WI, USA

Contract(s)/Grant(s): NAG5-5104; Copyright; Avail: CASI; [A01](#), Hardcopy

We report on the performance of our NTD-Ge microcalorimeters. To date, the spectral resolution for x-ray and gamma-ray lines from radioactive sources and laboratory plasmas is 4.8 eV in the entire 1 - 6 keV band and 52 eV at 60 keV. Technical details responsible for this performance are presented as well as an innovative electro-thermal approach for enhancing count-rate capability.

Author

*Gamma Ray Astronomy; X Ray Astronomy; Calorimeters; Germanium; Astrophysics; Additives*

**36**

**LASERS AND MASERS**

Includes lasing theory, laser pumping techniques, maser amplifiers, laser materials, and the assessment of laser and maser outputs. For cases where the application of the laser or maser is emphasized see also the specific category where the application is treated. For related information see also *76 Solid-State Physics*.

**20030020770** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Design and Performance of the Vegetation Canopy Lidar (VCL) Laser Transmitter**

Coyle, D. Barry; Kay, Richard B.; Lindauer, Steven J., II; [2002]; 26 pp.; In English; Original contains black and white illustrations; No Copyright; Avail: CASI; [A03](#), Hardcopy

The Vegetation Canopy Lidar (VCL) laser is a Nd:YAG Q-switched, diode side-pumped, zig-zag slab design producing 10 ns, 15 mJ pulses at 1064 nm. It employs an unstable resonator as well as a graded reflectivity output coupler with a Gaussian reflectivity profile. In order to conserve power, a conductively cooled design is employed and is designed to operate over a range of 25 C without active thermal control. The laser is an oscillator-only design and equipped with an 15X beam expander to limit the output divergence to less than 60 microrad. Thermal lensing compensation in the side-pumped slab was performed with different treatments of the x and y portions of the z-directed beam. Performance data as a function of temperature are given.

Author

*Optical Radar; Q Switched Lasers; Transmitters; Yag Lasers*

**37**

**MECHANICAL ENGINEERING**

Includes mechanical devices and equipment; machine elements and processes. For cases where the application of a device or the host vehicle is emphasized see also the specific category where the application or vehicle is treated. For robotics see *63 Cybernetics, Artificial Intelligence, and Robotics*; and *54 Man/System Technology and Life Support*.

**20030020784** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**High Frequency Low Amplitude Temperature Oscillations in Loop Heat Pipe Operation**

Ku, Jentung; [2003]; 28 pp.; In English; 33rd ICES Conference, 7-10 Jul. 2003, Vancouver, Canada; Original contains black and white illustrations; No Copyright; Avail: CASI; [A03](#), Hardcopy

The operating temperature of a loop heat pipe (LHP) with a single evaporator is governed by the compensation chamber (CC) temperature, which in turn is a function of the evaporator power, condenser sink temperature, and ambient temperature. As the operating condition changes, the CC temperature will change during the transient but eventually reach a new steady temperature. Under certain conditions, however, the LHP never really reaches a true steady state, but instead displays an oscillatory behavior. This paper presents a study on the oscillation of the loop operating temperature with amplitudes on the order of one degree Kelvin and frequencies on the order of  $10(\exp -1)$  to  $10(\exp -2)$  Hertz. The source of the high frequency temperature oscillation is the fast movement of the vapor front in the condenser section, which usually occurs when the vapor front is near the condenser inlet or the condenser outlet. At these locations, the vapor front is unable to find a stable position for the given operating conditions, and will move back and forth. The movement of the vapor front causes the movement of



the liquid in the condenser and the liquid line, leading to oscillations of the CC and the loop temperatures. Factors that affect the vapor front movement include evaporator power, condenser sink temperature, body forces and whether or the CC temperature is actively controlled. As long as there are no large thermal masses attached to the evaporator, the loop can self adjust rather quickly and the vapor front will move rapidly around the condenser inlet or outlet, leading to high frequency temperature oscillations. The amplitude of temperature oscillation is usually the largest in the liquid line, up to 20 degrees Kelvin in many cases, but diminishes to less than one degree Kelvin in the CC. Furthermore, the high frequency temperature oscillation can occur at any CC temperature when the right combination of the evaporator power and condenser sink temperature prevails.

Author

*Heat Transfer; Mathematical Models; Pipes (Tubes); Oscillations; High Frequencies; Heating Equipment*

**20030020786** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Progress Toward a Compact 0.05 K Magnet Refrigerator Operating from 10 K**

Canavan, Edgar; Shirron, Peter; DiPirro, Micheal; Tuttle, James; Jackson, Michael; King, Todd; Numazawa, Takenori; January 07, 2003; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Much of the most interesting information regarding our universe is hidden in the sub-millimeter, infrared, and x-rays bands of the spectrum, to which our atmosphere is largely opaque. Thus, missions exploring these bands are a very important part of NASA's Space Science program. Coincidentally, the most sensitive detectors in these spectral regions operate at extremely low temperatures, typically 0.05 - 0.10 K. Generally these temperatures will be achieved using magnetic refrigerators, also known as Adiabatic Demagnetization Refrigerators, or ADRs. Current ADRs, such as the one used in the XRS-II instrument on the Astro-E2 satellite, use a single-stage to cool detectors from 1.3 K to 0.06 K. The ADR is designed so that it can absorb the heat on the detector stage for at least 24 hours before it must stop, warm up to the helium bath temperature (1.3 K), and dump the accumulated heat. Future detector arrays will be much larger and will have higher heat dissipation. Furthermore, future missions will use mechanical cryocoolers to provide upper stage cooling, but they can only reach 4 - 10 K. Trying to scale heavy (~15 kg) single stage ADRs up to the higher heat loads and higher heat rejection temperatures required leads to unacceptably large systems. The GSFC Cryogenics Branch has developed the Continuous ADR (CADR) to solve this problem. The CADR consists of a series of ADR stages that sequentially pass heat from the load up to the high temperature heat sink. The stage connected to the load remains at a constant temperature. The continuous stage effectively decouples detector operation from ADR operation, allowing the ADR stages to be cycled much more rapidly. Rapid cycling leads to higher cooling power density. The cascading, multistage arrangement allows the magnetic refrigerant of each stage to be optimized for its own temperature swing. In the past year, we have made good progress toward a 0.05 to 10K system. A four-stage system that operates from 4.2 K was demonstrated. Magnetic shielding was added to eliminate inter-stage coupling. Improvements were made to superconducting and passive gas-gap heat switches. A second type of passive gas gap switch, one meant for use at higher temperature, was demonstrated. The presentation will focus primarily on these recent design improvements, and on the challenges that remain on the progress toward a system that will operate from 10 K or higher.

Author

*Low Temperature; Magnetic Cooling; Refrigerators; Operating Temperature; Cryogenics*

## 39

### STRUCTURAL MECHANICS

Includes structural element design, analysis and testing; dynamic responses of structures; weight analysis; fatigue and other structural properties; and mechanical and thermal stresses in structures. For applications see *05 Aircraft Design, Testing and Performance*; and *18 Spacecraft Design, Testing and Performance*.

**20030020677** NASA Glenn Research Center, Cleveland, OH, USA

**System Identification of Mistuned Bladed Disks from Traveling Wave Response Measurements**

Feiner, D. M.; Griffin, J. H.; Jones, K. W.; Kenyon, J. A.; Mehmed, O.; Kurkov, A. P.; [2003]; 23 pp.; In English; 19th Biennial ASME Conference on Mechanical Vibration and Noise, 2-6 Sep. 2003, Chicago, IL, USA; Original contains color illustrations; Copyright; Avail: CASI; [A03](#), Hardcopy

A new approach to modal analysis is presented. By applying this technique to bladed disk system identification methods, one can determine the mistuning in a rotor based on its response to a traveling wave excitation. This allows system

identification to be performed under rotating conditions, and thus expands the applicability of existing mistuning identification techniques from integrally bladed rotors to conventional bladed disks.

Author

*Traveling Waves; Vibration; Mistuning (Turbomachinery); Turbine Blades; Modal Response; System Identification*

**20030020824** NASA Glenn Research Center, Cleveland, OH, USA

**Tensile Creep of Polycrystalline Near-Stoichiometric NiAl**

Raj, Sai V.; November 25, 2002; 63 pp.; In English

Contract(s)/Grant(s): RTOP 708-31-20; RTOP 708-31-13

Report No.(s): E-13697; No Copyright; Avail: CASI; [A04](#), Hardcopy

Long term tensile creep studies were conducted on binary NiAl in the temperature range 700-1200 K with the objectives of characterizing and understanding the creep mechanisms. Inverse and normal primary creep curves were observed depending on stress and temperature. It was concluded that the creep of NiAl is limited by dislocation mobility. The stress exponent for creep,  $n$ , increased from 5.5 at 1200 K to 13.9 at 700 K. The true activation energy for creep,  $Q_c$ , was constant and equal to about 400 kJ per mole between 20 and 50 MPa but decreased to a constant value of 250 kJ per mole between 50 and 110 MPa. The activation energy was observed to be stress dependent above 110 MPa. The tensile creep results reported in this investigation were compared with compression creep data reported in the literature. A detailed discussion of the probable dislocation creep mechanisms governing compressive and tensile creep of NiAl is presented. It is concluded that the non-conservative motion of jogs on screw dislocations influenced the nature of the primary creep curves, where the climb of these jogs involves either the next nearest neighbor or the six-jump cycle vacancy diffusion mechanism. The probable nature of the atom vacancy exchange that occur within the core of an edge dislocation undergoing climb in NiAl are schematically examined.

Author

*Tensile Creep; Mechanical Properties; Nickel Aluminides; Polycrystals; Activation Energy; High Temperature Tests; Creep Analysis; Creep Tests*

## 42

### GEOSCIENCES (GENERAL)

Includes general research topics related to the Earth sciences, and the specific areas of petrology, mineralogy, and general geology. For other specific topics in geosciences see *categories 42 through 48*.

**20030020788** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Satellites as Sentinels for Environment & Health**

Maynard, Nancy G.; [2002]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

Satellites as Sentinels for Environment & Health Remotely-sensed data and observations are providing powerful new tools for addressing human and ecosystem health by enabling improved understanding of the relationships and linkages between health-related environmental parameters and society as well as techniques for early warning of potential health problems. NASA Office of Earth Science Applications Program has established a new initiative to utilize its data, expertise, and observations of the Earth for public health applications. In this initiative, lead by Goddard Space Flight Center, remote sensing, geographic information systems, improved computational capabilities, and interdisciplinary research between the Earth and health science communities are being combined in rich collaborative efforts resulting in more rapid problem-solving, early warning, and prevention in global health issues. This presentation provides a number of recent examples of applications of advanced remote sensing and other technologies to health and security issues related to the following: infectious and vector-borne diseases; urban, regional and global air pollution; African and Asian airborne dust; heat stress; UV radiation; water-borne disease; extreme weather; contaminant pathways (ocean, atmosphere, ice)

Author

*Air Sea Ice Interactions; Computer Techniques; Contaminants; Diseases; Dust; Global Air Pollution; Health; Public Health*



## EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth features, phenomena and resources by aircraft, balloon, rocket, and spacecraft; analysis of remote sensing data and imagery; development of remote sensing products; photogrammetry; and aerial photography. For related instrumentation see *35 Instrumentation and Photography*.

**20030020622** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Validation of Satellite Snow Cover Maps in North America and Norway**

Hall, Dorothy K.; Solberg, Rune; Riggs, George A.; July 2002; 9 pp.; In English; 59th Eastern Snow Conference; Original contains black and white illustrations; Copyright; Avail: CASI; [A02](#), Hardcopy

Satellite-derived snow maps from NASA's Earth Observing System Moderate Resolution Imaging Spectroradiometer (MODIS) have been produced since February of 2000. The global maps are available daily at 500-m resolution, and at a climate-modeling grid (CMG) resolution of 1/20 deg (approximately 5.6 km). We compared the 8-day composite CMG MODIS-derived global maps from November 1, 2001, through March 21, 2002, and daily CMG maps from February 26 - March 5, 2002, with National Oceanic and Atmospheric Administration (NOAA) Interactive Multisensor Snow and Ice Mapping System (IMS) 25-km resolution maps for North America. For the Norwegian study area, national snow maps, based on synoptic measurements as well as visual interpretation of AVHRR images, published by the Det Norske Meteorologiske Institutt (Norwegian Meteorological Institute) (MI) maps, as well as Landsat ETM+ images were compared with the MODIS maps. The MODIS-derived maps agreed over most areas with the IMS or MI maps, however, there are important areas of disagreement between the maps, especially when the 8-day composite maps were used. It is concluded that MODIS daily CMG maps should be studied for validation purposes rather than the 8-day composite maps, despite the limitations imposed by cloud obscuration when using the daily maps.

Author

*Snow Cover; Imaging Spectrometers; Satellite Observation; Remote Sensing; Climate Models; Ice Mapping*

**20030020635** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Comparison of Two Methods for Estimating the Sampling-Related Uncertainty of Satellite Rainfall Averages Based on a Large Radar Data Set**

Lau, William K. M., Technical Monitor; Bell, Thomas L.; Steiner, Matthias; Zhang, Yu; Wood, Eric F.; October 2002; 54 pp.; In English

Contract(s)/Grant(s): NAG5-7744; NAG5-9891; NA96GP0416; Copyright; Avail: CASI; [A04](#), Hardcopy

The uncertainty of rainfall estimated from averages of discrete samples collected by a satellite is assessed using a multi-year radar data set covering a large portion of the USA. The sampling-related uncertainty of rainfall estimates is evaluated for all combinations of 100 km, 200 km, and 500 km space domains, 1 day, 5 day, and 30 day rainfall accumulations, and regular sampling time intervals of 1 h, 3 h, 6 h, 8 h, and 12 h. These extensive analyses are combined to characterize the sampling uncertainty as a function of space and time domain, sampling frequency, and rainfall characteristics by means of a simple scaling law. Moreover, it is shown that both parametric and non-parametric statistical techniques of estimating the sampling uncertainty produce comparable results. Sampling uncertainty estimates, however, do depend on the choice of technique for obtaining them. They can also vary considerably from case to case, reflecting the great variability of natural rainfall, and should therefore be expressed in probabilistic terms. Rainfall calibration errors are shown to affect comparison of results obtained by studies based on data from different climate regions and/or observation platforms.

Author

*Statistical Analysis; Data Sampling; Error Analysis; Systematic Errors; Data Reduction; Rain; Radar Data; Meteorological Satellites*

**20030020719** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Remote Sensing of Cloud, Aerosol, and Land Properties from MODIS: Applications to the East Asia Region**

King, Michael D.; Platnick, Steven; Moody, Eric G.; [2002]; 1 pp.; In English; 2002 Workshop on GAME-T & Hydrometeorological Studies, October 29-30, 2002, Chiang Rai, Thailand; No Copyright; Avail: Other Sources; Abstract Only

MODIS is an earth-viewing cross-track scanning spectroradiometer launched on the Terra satellite in December 1999 and the Aqua satellite in May 2002. MODIS scans a swath width sufficient to provide nearly complete global coverage every two days from a polar-orbiting, sun-synchronous, platform at an altitude of 705 km, and provides images in 36 spectral bands between 0.415 and 14.235 microns with spatial resolutions of 250 m (2 bands), 500 m (5 bands) and 1000 m (29 bands). These

bands have been carefully selected to enable advanced studies of land, ocean, and atmospheric processes. In this paper we will describe the various methods being used for the remote sensing of cloud, aerosol, and surface properties using MODIS data, focusing primarily on (i) the MODIS cloud mask used to distinguish clouds, clear sky, heavy aerosol, and shadows on the ground, (ii) cloud optical properties, especially cloud optical thickness and effective radius of water drops and ice crystals, (iii) aerosol optical thickness and size characteristics both over land and ocean, and (iv) ecosystem classification and surface spectral reflectance. The physical principles behind the determination of each of these products will be described, together with an example of their application using MODIS observations to the east Asian region. All products are archived into two categories: pixel-level retrievals (referred to as Level-2 products) and global gridded products at a latitude and longitude resolution of 1 min (Level-3 products).

Derived from text

*Imaging Spectrometers; Remote Sensing; Cloud Physics; Aerosols; Asia; Spectroradiometers; Satellite Observation*

**20030020742** Washington Univ., Seattle, WA, USA

**Airborne Studies in the Arctic in Support of FIRE-III**

Hobbs, Peter V.; April 02, 2003; 5 pp.; In English

Contract(s)/Grant(s): NAG1-2079; Copyright; Avail: CASI; [A01](#), Hardcopy

This grant supported (i) the participation of the University of Washington's (UW) Cloud and Aerosol Research Group (CARG), with its Convair-580 research aircraft, in the FIRE-ACE field study in the Arctic; (ii) analyses of portions of the data collected; (iii) presentation of results at conferences and workshops; (iv) formal publication of results; and, (v) archiving of the data collected by the UW/CARG. The UW/CARG Convair-580 flew twenty-three research flights, totaling over 97 research hours, in the FIRE-ACE field study during the period 19 May through 24 June 1998. Six flights were beneath the NASA ER-2 aircraft, eight flights over the instrumented SHEBA ship, and eleven flights over the DOE ARM site in Barrow, Alaska. Measurements of cloud radiative properties and cloud structures were obtained in stratus, altocumulus and cirrus clouds. Aerosol measurements were obtained in polluted arctic haze, and in very clean conditions. Several new instruments were flown on the UW Convair-580, including the Gerber g-meter, the NASA/Goddard spectral full-scanning radiometer, and the SPEC cloud particle imager (CPI). A complete listing of all of the UW Convair-580 flights in FIRE-ACE is given in the report by Hobbs listed as (ii) in Section 3 below. The UW/CARG focussed its own analyses of these data on the airborne in situ measurements of clouds and aerosols. This resulted in five formal publications, covering topics ranging from the production of aerosols by clouds and aerosol effects on surface heating in the arctic, to the structures of arctic clouds and comparisons of in situ measurements of cloud structures with deductions from remote sensing measurements.

Author

*Arctic Regions; Cloud Physics; Clouds (Meteorology); Aerosols; Airborne Equipment; Atmospheric Chemistry*

**20030020772** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Precipitation Measurement from Space: The Next Generation**

Smith, Eric A.; [2002]; 1 pp.; In English; No Copyright; Avail: Other Sources; Abstract Only

During the coming decade, the internationally organized Global Precipitation Measurement (GPM) Mission will take an important step in creating a global rain observing system from space based on an international fleet of satellites operated as a constellation of opportunity. One perspective for understanding the nature of the mission is that it will be a hierarchical system of datastreams beginning with very high caliber combined dual frequency rain-radar/passive microwave rain-radiometer retrievals, to high caliber rain-radiometer only retrievals, and then on to blends of the former datastreams with additional lower-caliber microwave- and infrared-based rain retrievals. Within the context of the now emerging global water & energy cycle (GWEC) research programs of a number of research agencies throughout the world, the GPM mission serves as a centerpiece space mission for improving our understanding of the Earth's water cycle from global scale and on down to regional scales and below. One of the salient problems within our current understanding of the global water and energy cycle is determining whether a change in the rate of the water cycle is accompanying changes in climate, e.g., global water cycle acceleration accompanying global warming. As there are a number of ways in which to define a rate-change of the water cycle, it has not always been clear as to what constitutes a conclusive determination. This seminar presents an overview of the GPM Mission and how its overriding scientific objectives for climate, weather, and hydrology flow from the anticipated improvements that are being planned for the constellation-based measuring system, and how this mission may offer, over the long run, a more fundamental means to ascertain water cycle accelerations.

Author

*Rain; Meteorological Satellites; Satellite Constellations; Hydrological Cycle*

**20030020801** NASA Langley Research Center, Hampton, VA, USA

**Evaluation of Methods to Estimate the Surface Downwelling Longwave Flux during Arctic Winter**

Chiacchio, Marc; Francis, Jennifer; Stackhouse, Paul, Jr.; Journal of Applied Meteorology; [2002]; Volume 41, pp. 306-318; In English

Contract(s)/Grant(s): NAG1-1908; NAG1-2058; Copyright; Avail: CASI; [A03](#), Hardcopy

Surface longwave radiation fluxes dominate the energy budget of nighttime polar regions, yet little is known about the relative accuracy of existing satellite-based techniques to estimate this parameter. We compare eight methods to estimate the downwelling longwave radiation flux and to validate their performance with measurements from two field programs in the Arctic: the Coordinated Eastern Arctic Experiment (CEAREX) conducted in the Barents Sea during the autumn and winter of 1988, and the Lead Experiment performed in the Beaufort Sea in the spring of 1992. Five of the eight methods were developed for satellite-derived quantities, and three are simple parameterizations based on surface observations. All of the algorithms require information about cloud fraction, which is provided from the NASA-NOAA Television and Infrared Observation Satellite (TIROS) Operational Vertical Sounder (TOVS) polar pathfinder dataset (Path-P): some techniques ingest temperature and moisture profiles (also from Path-P): one-half of the methods assume that clouds are opaque and have a constant geometric thickness of 50 hPa, and three include no thickness information whatsoever. With a somewhat limited validation dataset, the following primary conclusions result: (1) all methods exhibit approximately the same correlations with measurements and rms differences, but the biases range from -34 W sq m (16% of the mean) to nearly 0; (2) the error analysis described here indicates that the assumption of a 50-hPa cloud thickness is too thin by a factor of 2 on average in polar nighttime conditions; (3) cloud-overlap techniques, which effectively increase mean cloud thickness, significantly improve the results; (4) simple Arctic-specific parameterizations performed poorly, probably because they were developed with surface-observed cloud fractions; and (5) the single algorithm that includes an estimate of cloud thickness exhibits the smallest differences from observations.

Author

*Long Wave Radiation; Arctic Regions; Flux (Rate); Winter; Satellite Observation; Error Analysis; Night*

## 44

### ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; and solar, geothermal, windpower, and waterwave conversion systems; energy storage; and traditional power generators. For technologies related to nuclear energy production see *73 Nuclear Physics*. For related information see also *07 Aircraft Propulsion and Power*; *20 Spacecraft Propulsion and Power*, and *28 Propellants and Fuels*.

**20030020851** Akron Univ., Akron, OH, USA

**Optimal Charging of Nickel-Hydrogen Batteries for Life Extension**

Hartley, Tom T.; Lorenzo, Carl F.; [2002]; 20 pp.; In English

Contract(s)/Grant(s): NCC3-820; Copyright; Avail: CASI; [A03](#), Hardcopy

We are exploring the possibility of extending the cycle life of battery systems by using a charging profile that minimizes cell damage. Only nickel-hydrogen cells are discussed at this time, but applications to lithium-ion cells are being considered. The process first requires the development of a fractional calculus based nonlinear dynamic model of the specific cells being used. The parameters of this model are determined from the cell transient responses. To extend cell cycle life, an instantaneous damage rate model is developed. The model is based on cycle life data and is highly dependent on cell voltage. Once both the cell dynamic model and the instantaneous damage rate model have been determined, the charging profile for a specific cell is determined by numerical optimization. Results concerning the percentage life extension for different charging strategies are presented. The overall procedure is readily adaptable to real-time implementations where the charging profile can maintain its minimum damage nature as the specific cell ages.

Author

*Life (Durability); Nickel Hydrogen Batteries; Electric Charge; Design Optimization; Dynamic Models; Cumulative Damage*

## ENVIRONMENT POLLUTION

Includes atmospheric, water, soil, noise, and thermal pollution.

**20030020835** Oklahoma State Univ., Stillwater, OK, USA

### Terrestrial Environmental Variables Derived From EOS Platform Sensors

Stadler, Stephen J.; Czajkowski, Kevin P.; Goward, Samuel N.; Xue, Yongkang; [2001]; 7 pp.; In English

Contract(s)/Grant(s): NAG5-787

Report No.(s): OSU-AA-5-51109; No Copyright; Avail: CASI; [A02](#), Hardcopy

The three main objectives of the overall project were: 1. Adaptation of environmental constraint methods to take advantage of EOS sensors, specifically, MODIS, ASTER, and Landsat-7, in addition to the PM AVHRR observations 2. Refinement of environmental constraint methods based on fundamental scientific knowledge. 3. Assessment of spatial scaling patterns in environmental constraint measurements to evaluate the potential biases and errors that occur when estimating regional and global-scale NPP patterns with moderate to coarse satellite observations. These goals were modified because, on one hand, MODIS data did not become available until after the first year of the project and because of project staffing issues at the University of Maryland., The OSU portion of the project contained a modest amount of funding and responsibility compared to the University of Maryland and the University of Toledo.

Derived from text

*Advanced Very High Resolution Radiometer; Errors; Environmental Monitoring; Environmental Surveys*

## GEOPHYSICS

Includes Earth structure and dynamics, aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism. For related information see *47 Meteorology and Climatology*; and *93 Space Radiation*.

**20030020621** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

### Gravitational Lenses and the Structure and Evolution of Galaxies

Kochanek, Christopher; March 18, 2003; 3 pp.; In English

Contract(s)/Grant(s): NAG5-9265; No Copyright; Avail: CASI; [A01](#), Hardcopy

The grant has supported the completion of 16 papers and 4 conference proceedings to date. During the first year of the project we completed five papers, each of which represents a new direction in the theory and interpretation of gravitational lenses. In the first paper, 'The Importance of Einstein Rings', we developed the first theory for the formation and structure of the Einstein rings formed by lensing extended sources like the host galaxies of quasar and radio sources. We applied the theory to three lenses with lensed host galaxies. For the time delay lens PG 1115+080 we found that the structure of the Einstein ring ruled out models of the gravitational potential which permitted a large Hubble constant (70 km/s Mpc). In the second paper, 'Cusped Mass Models Of Gravitational Lenses', we introduced a new class of lens models where the central density is characterized by a cusp ( $\rho$  proportional to  $\tau^{sup-\gamma}$ ),  $1 < \gamma < 2$ ) as in most modern models and theories of galaxies rather than a finite core radius. In the third paper, 'Global Probes of the Impact of Baryons on Dark Matter Halos', we made the first globally consistent models for the separation distribution of gravitational lenses including both galaxy and cluster lenses. We show that the key physics for the origin of the sharp separation cutoff in the separation distribution near 3 arc sec is the effect of the cooling baryons in galaxies on the density structure of the system.

Derived from text

*Astronomical Models; Galactic Evolution; Galactic Structure; Gravitational Lenses*

**20030020763** Ohio State Univ., Columbus, OH, USA

### Understanding Recent Mass Balance Changes of the Greenland Ice Sheet

vanderVeen, Cornelius; February 28, 2003; 10 pp.; In English

Contract(s)/Grant(s): NAG5-11749; No Copyright; Avail: CASI; [A02](#), Hardcopy

The ultimate goal of this project is to better understand the current transfer of mass between the Greenland Ice Sheet, the world's oceans and the atmosphere, and to identify processes controlling the rate of this transfer, to be able to predict with greater confidence future contributions to global sea level rise. During the first year of this project, we focused on establishing longer-term records of change of selected outlet glaciers, reevaluation of mass input to the ice sheet and analysis of climate

records derived from ice cores, and modeling meltwater production and runoff from the margins of the ice sheet.

Author

*Greenland; Land Ice; Mass Distribution; Glaciers; Ice Reporting; Mass Transfer; Sea Level; Water Runoff*

**20030020802** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Gravity Fields from CHAMP Mission Data**

Lemoine, Frank G.; Luthcke, S. B.; Cox, C. M.; Rowlands, D. D.; Thompson, B. F.; Chinn, D. S.; Williams, T. A.; Nerem, R. S.; [2002]; 1 pp.; In English; American Geophysical Union Meeting, 6-10 Dec. 2002, San Francisco, CA, USA; No Copyright; Avail: Other Sources; Abstract Only

The CHAMP mission, launched in July 2000, is the first in a series of missions that will revolutionize our ability to model the Earth's geopotential. The CHAMP spacecraft is equipped for precision tracking by the Global Positioning System (GPS) and Satellite Laser Ranging (SLR) along with a precision accelerometer to provide measurements of the surface forces. Preliminary satellite-only geopotential solutions with only 30 days of CHAMP data are, by some criteria, as strong as solutions made from tracking data collected over the previous 30 years of the space age. Compared to EGM96, CHAMP makes notable contributions in regions where the terrestrial data (surface gravimetry and altimetry) were weak, for example in the polar regions, in the Amazon and the Himalayas. The CHAMP data allow us to separate the geoid from the dynamic ocean topography (DOT) up to at least degree 25 rather than just under degree 20 as in EGM96. We report on satellite-only and combination models that incorporate up to 100 days of CHAMP data as well as other satellite data. We report on our updated processing of the CHAMP tracking and accelerometer data and evaluate the performance of the geopotential models using a variety of tests.

Author

*Gravitational Fields; Geopotential; Satellite Observation; Satellite Laser Ranging; Geodetic Satellites; Geoids*

**20030020809** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Time-Variable Gravity Signal Due to Extratropic Pacific Water Mass Redistribution**

Chao, Benjamin F.; Au, A. Y.; Cox, C. M.; [2002]; 1 pp.; In English; American Geophysical Union Meeting, 6-10 Dec. 2002, San Francisco, CA, USA; No Copyright; Avail: Other Sources; Abstract Only

Cox and Chao [2002] reported the detection of a large anomaly in the form of a positive 'jump' in the time series of Earth's lowest-degree gravity harmonic J<sub>2</sub>, or the dynamic oblateness, during 1998. This prompted us to examine the mass redistribution in the global oceans. We report here a seesaw of the sea-surface height (SSH) in the extratropic north + south Pacific basins -- the leading (nonseasonal) EOF/PC mode in SSH derived from the 10-year TOPEX/Poseidon altimetry data in the extratropic Pacific region. The mode underwent a step-like jump with time evolution that match remarkably well with the observed J<sub>2</sub> anomaly. However, the magnitude is several times too small to explain the observed J<sub>2</sub>, even if assuming the SSH jump was all mass-induced (as opposed to any steric effect which causes no time-variable gravity signal). If one accepts the notion that this extratropic Pacific seesaw is part of the geophysical process that produced the observed 1998 J<sub>2</sub> anomaly, then this finding suggests strong geophysical connection of the interannual-to-decadal variation of J<sub>2</sub> with the Pacific Decadal Oscillation (PDO), as the time series of the above EOF/PC mode is actually a formally defined PDO Index series.

Author

*Geophysics; Pacific Ocean; Anomalies; Harmonic Oscillation; Periodic Variations; Water Flow; Ocean Dynamics*

**20030020816** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Properties of Minor Ions in the Solar Wind and Implications for the Background Solar Wind Plasma**

Esser, Ruth; Wagner, William, Technical Monitor; March 2003; 3 pp.; In English  
Contract(s)/Grant(s): NAG5-10996; No Copyright; Avail: CASI; A01, Hardcopy

Ion charge states measured in situ in interplanetary space are formed in the inner coronal regions below 5 solar radii, hence they carry information on the properties of the solar wind plasma in that region. The plasma parameters that are important in the ion forming processes are the electron density, the electron temperature and the flow speeds of the individual ion species. In addition, if the electron distribution function deviates from a Maxwellian already in the inner corona, then the enhanced tail of that distribution function, also called halo, greatly effects the ion composition. The goal of the proposal is to make use of ion fractions observed in situ in the solar wind to learn about both, the plasma conditions in the inner corona and



the expansion and ion formation itself. This study is carried out using solar wind models, coronal observations, and ion fraction calculations in conjunction with the in situ observations.

Author

*Electron Density (Concentration); Electron Distribution; Ion Charge; Solar Wind; Solar Wind Velocity; Background Radiation*

**20030020836** Ohio State Univ., Columbus, OH, USA

**Airborne Geophysics and Remote Sensing Applied to Study Greenland Ice Dynamics**

Csatho, Beata M.; February 27, 2003; 5 pp.; In English

Contract(s)/Grant(s): NAG5-10199; No Copyright; Avail: CASI; [A01](#), Hardcopy

Overview of project: we combined and jointly analysed geophysical, remote sensing and glaciological data for investigating the temporal changes in ice flow and the role of geologic control on glacial drainage. The project included two different studies, the investigation of recent changes of the Kangerlussuaq glacier and the study of geologic control of ice flow in NW Greenland, around the Humboldt, Petermann and Ryder glaciers.

Author

*Aerial Reconnaissance; Geophysics; Remote Sensing; Ice Formation*

**20030020856** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Crustal Deformation in Southcentral Alaska: The 1964 Prince William Sound Earthquake Subduction Zone**

Cohen, Steven C.; Freymueller, Jeffrey T.; [2003]; 84 pp.; In English; Original contains black and white illustrations; Copyright; Avail: CASI; [A05](#), Hardcopy

This article, for *Advances in Geophysics*, is a summary of crustal deformation studies in southcentral Alaska. In 1964, southcentral Alaska was struck by the largest earthquake (moment magnitude 9.2) occurring in historical times in North America and the second largest earthquake occurring in the world during the past century. Conventional and space-based geodetic measurements have revealed a complex temporal-spatial pattern of crustal movement. Numerical models suggest that ongoing convergence between the North America and Pacific Plates, viscoelastic rebound, aseismic creep along the tectonic plate interface, and variable plate coupling all play important roles in controlling both the surface and subsurface movements. The geodetic data sets include tide-gauge observations that in some cases provide records back to the decades preceding the earthquake, leveling data that span a few decades around the earthquake, VLBI data from the late 1980s, and GPS data since the mid-1990s. Geologic data provide additional estimates of vertical movements and a chronology of large seismic events. Some of the important features that are revealed by the ensemble of studies that are reviewed in this paper include: (1) Crustal uplift in the region that subsided by up to 2 m at the time of the earthquake is as much as 1 m since the earthquake. In the Turnagain Arm and Kenai Peninsula regions of southcentral Alaska, uplift rates in the immediate aftermath of the earthquake reached 150 mm/yr, but this rapid uplift decayed rapidly after the first few years following the earthquake. (2) At some other locales, notably those away from the coseismic rupture zone, postseismic uplift rates were initially slower but the rates decay over a longer time interval. At Kodiak Island, for example, the uplift rates have been decreasing at a rate of about 7 mm/yr per decade. At yet other locations, the uplift rates have shown little time dependence so far, but are thought not to be sustainable throughout the several hundred year recurrence time for great earthquake. The nearly 10 mm/yr uplift rate at Seldovia on the Kenai Peninsula is an example.

Author

*Alaska; Earthquakes; Earth Crust; Deformation; Crustal Fractures*

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### METEOROLOGY AND CLIMATOLOGY

Includes weather observation forecasting and modification.

**20030020725** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**A Stochastic Model of Space-Time Variability of Tropical Rainfall: I. Statistics of Spatial Averages**

Kundu, Prasun K.; Bell, Thomas L.; Lau, William K. M., Technical Monitor; [2002]; 23 pp.; In English; Copyright; Avail: CASI; [A03](#), Hardcopy

Global maps of rainfall are of great importance in connection with modeling of the earth's climate. Comparison between the maps of rainfall predicted by computer-generated climate models with observation provides a sensitive test for these

models. To make such a comparison, one typically needs the total precipitation amount over a large area, which could be hundreds of kilometers in size over extended periods of time of order days or months. This presents a difficult problem since rain varies greatly from place to place as well as in time. Remote sensing methods using ground radar or satellites detect rain over a large area by essentially taking a series of snapshots at infrequent intervals and indirectly deriving the average rain intensity within a collection of pixels, usually several kilometers in size. They measure area average of rain at a particular instant. Rain gauges, on the other hand, record rain accumulation continuously in time but only over a very small area tens of centimeters across, say, the size of a dinner plate. They measure only a time average at a single location. In making use of either method one needs to fill in the gaps in the observation - either the gaps in the area covered or the gaps in time of observation. This involves using statistical models to obtain information about the rain that is missed from what is actually detected. This paper investigates such a statistical model and validates it with rain data collected over the tropical Western Pacific from ship borne radars during TOGA COARE (Tropical Oceans Global Atmosphere Coupled Ocean-Atmosphere Response Experiment). The model incorporates a number of commonly observed features of rain. While rain varies rapidly with location and time, the variability diminishes when averaged over larger areas or longer periods of time. Moreover, rain is patchy in nature - at any instant on the average only a certain fraction of the observed pixels contain rain. The fraction of area covered by rain decreases, as the size of a pixel becomes smaller. This means that within what looks like a patch of rainy area in a coarse resolution view with larger pixel size, one finds clusters of rainy and dry patches when viewed on a finer scale. The model makes definite predictions about how these and other related statistics depend on the pixel size. These predictions were found to agree well with data. In a subsequent second part of the work we plan to test the model with rain gauge data collected during the TRMM (Tropical Rainfall Measuring Mission) ground validation campaign.

Author

*Stochastic Processes; Mathematical Models; Time Dependence; Tropical Regions; Rain; Climate Models*

**20030020726** Alabama Univ., Huntsville, AL, USA

#### **Ozone Retrieval Error Associated with Clouds**

Newchurch, Michael J.; August 2002; 3 pp.; In English

Contract(s)/Grant(s): NAG5-10965; No Copyright; Avail: CASI; [A01](#), Hardcopy

This research addresses the following three objectives: (1) quantify ozone retrieval errors due to assuming Lambertian clouds, (2) quantify ozone retrieval errors due to assuming opaque clouds. (3) Investigate the effects of assuming cloud reflectivity to be 80% on ozone retrieval.

Author

*Clouds (Meteorology); Errors; Ozone*

**20030020730** NASA Goddard Space Flight Center, Greenbelt, MD, USA

#### **Perspectives on Forced Predictability**

Schubert, S.; Chang, Y.; Suarez, M.; [2003]; 1 pp.; In English; The Known/Unknown/Unknowable in Predictability of Weather Workshop, 17-19 Feb. 2003, Savannah, GA, USA; No Copyright; Avail: Other Sources; Abstract Only

This talk addresses the relationships between weather and El Nino/Southern Oscillation (ENSO) and various other low frequency atmospheric variations such as the Pacific/North American pattern. We focus, in particular, on the predictability of extreme wintertime precipitation events over the continental USA. We first examine fifty years of daily precipitation observations and quantify the leading patterns of winter weather variability. These weather systems, familiar to operational weather forecasters, account for many of the major flooding events on the west coast as well as the major winter snowstorms along the east coast. We next examine the statistics of these storm systems with a particular focus on the occurrence of extreme events. The leading weather systems show varying degrees of linkages to low frequency atmospheric variability. We show, for example, that on seasonal time scales the probability of occurrence of certain types of west coast storms is strongly enhanced by El Nino, while it is reduced during winters with an anomalous trough to the west of the dateline. ENSO also has a strong impact on storms that develop over the Gulf of Mexico and affect much of the eastern USA, with enhanced storminess during El Nino, and reduced storminess during La Nina conditions. We conclude with an example of how well current climate models are able to reproduce the basic linkages between weather and low frequency variability.

Author

*Climate Models; Weather Forecasting; Southern Oscillation; El Nino; Probability Theory; Snowstorms*



**20030020733** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Global Precipitation Analyses at Monthly to 3-HR Time Scales**

Adler, Robert F.; Huffman, George; Curtis, Scott; Bolvin, David; Nelkin, Eric; January 2002; 1 pp.; In English; International Precipitation Working Group Workshop, 23-27 Sep. 2002, Madrid, Spain; No Copyright; Avail: Other Sources; Abstract Only

Global precipitation analysis covering the last few decades and the impact of the new TRMM precipitation observations are discussed. The 20+ year, monthly, globally complete precipitation analysis of the World Climate Research Program's (WCRP/GEWEX) Global Precipitation Climatology Project (GPCP) is used to explore global and regional variations and trends and is compared to the much shorter TRMM (Tropical Rainfall Measuring Mission) tropical data set. A trend pattern that is a combination of both El Nino and La Nina precipitation features is evident in the 20-year data set. This pattern is related to an increase with time in the number of combined months of El Nino and La Nina during the 20 year period. Monthly anomalies of precipitation are related to ENSO variations with clear signals extending into middle and high latitudes of both hemispheres. The GPCP daily, 1deg latitude-longitude analysis, which is available from January 1997 to the present is described and the evolution of precipitation patterns on this time scale related to El Nino and La Nina is described. Finally, a TRMM-based 3-hr analysis is described that uses TRMM to calibrate polar-orbit microwave observations from SSM/I and geosynchronous IR observations and merges the various calibrated observations into a final, 3-hr resolution map. This TRMM standard product will soon be available for the entire TRMM period (January 1998- present). A real-time version of this merged product is being produced and is available at 0.25deg latitude-longitude resolution over the latitude range from 50degN-50degS. Images from this data set can be seen at the U.S. TRMM web site ([trmm.gsfc.nasa.gov](http://trmm.gsfc.nasa.gov)). Examples will be shown, including its use in monitoring flood conditions and relating weather-scale events to climate variations.

Author

*Precipitation (Meteorology); Infrared Astronomy; Climatology; Microwave Imagery; Trmm Satellite*

**20030020773** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**A TRMM-Calibrated Infrared Technique for Global Rainfall Estimation**

Negri, Andrew J.; Adler, Robert F.; January 2002; 1 pp.; In English; International Precipitation Working Group Workshop, 23-27 Sep. 2002, Madrid, Spain; No Copyright; Avail: Other Sources; Abstract Only

The development of a satellite infrared (IR) technique for estimating convective and stratiform rainfall and its application in studying the diurnal variability of rainfall on a global scale is presented. The Convective-Stratiform Technique (CST), calibrated by coincident, physically retrieved rain rates from the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR), is applied over the global tropics during 2001. The technique is calibrated separately over land and ocean, making ingenious use of the IR data from the TRMM Visible/Infrared Scanner (VIRS) before application to global geosynchronous satellite data. The low sampling rate of TRMM PR imposes limitations on calibrating IR-based techniques; however, our research shows that PR observations can be applied to improve IR-based techniques significantly by selecting adequate calibration areas and calibration length. The diurnal cycle of rainfall, as well as the division between convective and stratiform rainfall will be presented. The technique is validated using available data sets and compared to other global rainfall products such as Global Precipitation Climatology Project (GPCP) IR product, calibrated with TRMM Microwave Imager (TMI) data. The calibrated CST technique has the advantages of high spatial resolution (4 km), filtering of non-raining cirrus clouds, and the stratification of the rainfall into its convective and stratiform components, the latter being important for the calculation of vertical profiles of latent heating.

Author

*Trmm Satellite; Infrared Scanners; Rain; Microwave Imagery; Estimating*

**20030020781** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Application of Local Discretization Methods in the NASA Finite-Volume General Circulation Model**

Yeh, Kao-San; Lin, Shian-Jiann; Rood, Richard B.; July 17, 2002; 8 pp.; In English; Original contains color illustrations; No Copyright; Avail: CASI; [A02](#), Hardcopy

We present the basic ideas of the dynamics system of the finite-volume General Circulation Model developed at NASA Goddard Space Flight Center for climate simulations and other applications in meteorology. The dynamics of this model is designed with emphases on conservative and monotonic transport, where the property of Lagrangian conservation is used to maintain the physical consistency of the computational fluid for long-term simulations. As the model benefits from the noise-free solutions of monotonic finite-volume transport schemes, the property of Lagrangian conservation also partly compensates the accuracy of transport for the diffusion effects due to the treatment of monotonicity. By faithfully maintaining the fundamental laws of physics during the computation, this model is able to achieve sufficient accuracy for the global

consistency of climate processes. Because the computing algorithms are based on local memory, this model has the advantage of efficiency in parallel computation with distributed memory. Further research is yet desirable to reduce the diffusion effects of monotonic transport for better accuracy, and to mitigate the limitation due to fast-moving gravity waves for better efficiency.

Author

*Atmospheric General Circulation Models; Finite Volume Method; Discretization (Mathematics); Monotone Functions*

**20030020782** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Vertical Profiles of Latent Heat Release over the Global Tropics using TRMM rainfall products from December 1997 to November 2001**

Tao, W.-K.; Lang, S.; Simpson, J.; Meneghini, R.; Halverson, J.; Johnson, R.; Adler, R.; January 2002; 1 pp.; In English; TRMM Science Conference, 22-26 Jul. 2002, Honolulu, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

NASA Tropical Rainfall Measuring Mission (TRMM) precipitation radar (PR) derived rainfall information will be used to estimate the four-dimensional structure of global monthly latent heating and rainfall profiles over the global tropics from December 1997 to November 2001. Rainfall, latent heating and radar reflectivity structures between El Nino (DE 1997-98) and La Nina (DJF 1998-99) will be examined and compared. The seasonal variation of heating over various geographic locations (i.e., oceanic vs continental, Indian ocean vs. west Pacific, Africa vs. S. America) will also be analyzed. In addition, the relationship between rainfall, latent heating (maximum heating level), radar reflectivity and SST is examined and will be presented in the meeting. The impact of random error and bias in stratiform percentage estimates from PR on latent heating profiles is studied and will also be presented in the meeting. The Goddard Cumulus Ensemble Model is being used to simulate various mesoscale convective systems that developed in different geographic locations. Specifically, the model estimated rainfall, radar reflectivity and latent heating profiles will be compared to observational data collected from TRMM field campaigns over the South China Sea in 1998 (SCSMEX), Brazil in 1999 (TRMM-LBA), and the central Pacific in 1999 (KWAJEX). Sounding diagnosed heating budgets and radar reflectivity from these experiments can provide the means to validate (heating product) as well as improve the GCE model.

Author

*Mesoscale Phenomena; Precipitation (Meteorology); Annual Variations; Atmospheric Models; Heat Transfer; Latent Heat; Meteorological Radar; Rain*

**20030020796** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Prospects for Improved Forecasts of Weather and Short-Term Climate Variability on Subseasonal (2-Week to 2-Month) Time Scales**

Schubert, Siegfried; Dole, Randall; vandenDool, Huug; Suarez, Max; Waliser, Duane; November 2002; 163 pp.; In English; Original contains color illustrations

Report No.(s): NASA/TM-2002-104606/VOL23; Rept-2002-00538/VOL23; NAS 1.15:104606/VOL23; No Copyright; Avail: CASI; A08, Hardcopy

A workshop was held in April of 2002 that brought together various experts in the Earth Sciences to focus on the subseasonal prediction problem. While substantial advances have occurred over the last few decades in both weather and seasonal prediction, progress in improving predictions on these intermediate time scales (time scales ranging from about two weeks to two months) has been slow. The goals of the workshop were to get an assessment of the 'state of the art' in predictive skill on these time scales, to determine the potential sources of 'untapped' predictive skill, and to make recommendations for a course of action that will accelerate progress in this area. A remarkable aspect of the workshop was the multi-disciplinary nature of the attendees, consisting of about 100 scientists with specialties in areas that included stratospheric dynamics, hydrology and land surface modeling, the monsoons, the Madden-Julian Oscillation (MJO) and other tropical variability, extratropical variability including extratropical-tropical interactions, coupled atmosphere-ocean-land modeling, weather prediction, seasonal prediction, and various aspects of statistical modeling, analysis, and prediction. This broad range of expertise reflected the wide array of physical processes that are deemed potentially important sources of predictive skill on subseasonal time scales. One of the key conclusions of the workshop was that there is compelling evidence for predictability at forecast lead times substantially longer than two weeks. Tropical diabatic heating and soil wetness were singled out as particularly important processes affecting predictability on these time scales. Predictability was also linked to various low-frequency atmospheric phenomena such as the annular modes in high latitudes (including their connections to the stratosphere), the Pacific/North American pattern (PNA), and the MJO. The latter, in particular, was highlighted as a key source of untapped predictability in the tropics and subtropics, including the Asian and Australian monsoon regions. The key recommendations of the workshop are: a) That a coordinated and systematic analysis of current subseasonal forecast skill be

conducted by generating ensembles of 30-day hindcasts for the past 30-50 years with several 'fbzen' AGCMs. Specific goals include, sampling all seasons, and generating sufficiently large ensembles to estimate the evolution of the probability density function. b) That a series of workshops be convened focused on modeling the MJO, and that a coordinated multi-nation/multi-model experimental prediction program be developed focused on the MJO. c) That new satellite observations and new long-term consistent reanalysis data sets be developed for initialization and verification, with high priority given to improvements in estimates of tropical diabatic heating and cloud processes, soil moisture, and surface fluxes (including evaporation over land). a) That NASA and NOAA develop a collaborative program to coordinate, focus, and support research on predicting subseasonal variability. Specific steps to implement the above recommendations are: 1) to begin immediately to develop a framework for an experimental MJO prediction program, 2) to convene a follow-up workshop in the spring of 2003 to organize the AGCM hindcast project, and conduct initial meetings on modeling the MJO, and 3) for NASA and NOAA to put out a joint announcement of opportunity within the next year to focus research, modeling and data development efforts on the subseasonal prediction problem.

Author

*Weather Forecasting; Climate; Time Dependence; Atmospheric Models; Estimates; Heat Transfer; Marine Meteorology; Mathematical Models*

**20030020803** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Using Kalman Filter Chemical Data Assimilation To Study Ozone Catalytic Loss Cycles In January 1992**

Lary, David J.; [2002]; ISSN 0148-0227; 9 pp.; In English

Report No.(s): Paper; Copyright; Avail: Other Sources

This paper presents for the first time a global study of the ozone catalytic destruction cycles operating in the stratosphere using a stratospheric analyses for January 1992. The chemical analyses were produced using a Kalman filter data assimilation system. Because a major component of the variability of trace gases is due to the atmospheric motions the analyses have been cast in a flow-tracking coordinate system that moves with the large scale flow pattern. Particular attention is paid to the kinetic aspects of these cycles such as the rate limiting step and chain length. Although it is an important kinetic parameter, the chain length of the various cycles is seldom considered when the various catalytic cycles are discussed. This survey highlights that in the low stratosphere the cycles involving HO<sub>2</sub> and halogens (notably bromine) are particularly important. In approximate order of effectiveness the most important ozone loss cycles in the polar lower stratosphere are the BrO/ClO, HO<sub>2</sub>/BrO, and OH/HO<sub>2</sub> cycles. The ClO/ClO cycle clearly delineates the regions of chlorine activation. The chain length of the HO<sub>2</sub>/ClO, OH/HO<sub>2</sub>, Br/BrO, and ClO/NO<sub>2</sub>, clearly delineate the vortex edge region. The chain length of the BrO/NO<sub>2</sub> and Cl/NO<sub>2</sub> cycles highlight the regions of chemical processing outside the vortex where streamers of chemically processed air are stripped-off and transported away from the vortex. This is also true in the very low stratosphere for the Cl/ClO and BrO/ClO cycles.

Author

*Kalman Filters; Chemical Analysis; Ozone; Losses; Cycles; Catalytic Activity*

**20030020807** NASA Goddard Space Flight Center, Greenbelt, MD, USA

### **Barometric Tides from ECMWF Operational Analyses**

Ray, R. D.; Ponte, R. M.; January 2003; 27 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): Proj. 1206432; Copyright; Avail: CASI; [A03](#), Hardcopy

The solar diurnal and semidiurnal tidal oscillations in surface pressure are extracted from the the operational analysis product of the European Centre for Medium Range Weather Forecasting (ECMWF). For the semidiurnal tide this involves a special temporal interpolation, following Van den Dool and colleagues. The resulting tides are compared with a ground truth tide dataset, a compilation of well-determined tide estimates deduced from long time series of station barometer measurements. These comparisons show that the ECMWF tides are significantly more accurate than the tides deduced from two other widely available reanalysis products. Spectral analysis of ECMWF pressure series shows that the tides consist of sharp central peaks with modulating sidelines at integer multiples of 1 cycle/year, superimposed on a broad cusp of stochastic energy. The integrated energy in the cusp dominates that of the sidelines. This complicates development of a simple model that can characterize the full temporal variability of the tides.

Author

*Atmospheric Pressure; Diurnal Variations; Models; Solar Oscillations; Spectrum Analysis; Time Series Analysis; Weather Forecasting*

**20030020815** Alabama Univ., Huntsville, AL, USA

**Derivation of Tropospheric Ozone Climatology and Trends from TOMS Data**

Newchurch, Michael J.; McPeters, Rich; Logan, Jennifer; Kim, Jae-Hwan; August 1, 2002; 5 pp.; In English

Contract(s)/Grant(s): NAG5-7269; No Copyright; Avail: CASI; [A01](#), Hardcopy

This research addresses the following three objectives: (1) Derive tropospheric ozone columns from the TOMS instruments by computing the difference between total-ozone columns over cloudy areas and over clear areas in the tropics; (2) Compute secular trends in Nimbus-7 derived tropospheric Ozone column amounts and associated potential trends in the decadal-scale tropical cloud climatology; (3) Explain the occurrence of anomalously high ozone retrievals over high ice clouds.

Author

*Ozone; Troposphere; Total Ozone Mapping Spectrometer; Applications Programs (Computers); Transport Properties; Cloud Cover; Bidirectional Reflectance*

**20030020819** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Numerical Simulation of the Water Cycle Change Over the 20th Century**

Bosilovich, Michael G.; Schubert, Siegfried D.; [2003]; 1 pp.; In English; Tenth US-Japan Workshop on Global Change, 15-16 Jan. 2003, Irvine, CA, USA; No Copyright; Avail: Other Sources; Abstract Only

We have used numerical models to test the impact of the change in Sea Surface Temperatures (SSTs) and carbon dioxide (CO<sub>2</sub>) concentration on the global circulation, particularly focusing on the hydrologic cycle, namely the global cycling of water and continental recycling of water. We have run four numerical simulations using mean annual SST from the early part of the 20th century (1900-1920) and the later part (1980-2000). In addition, we vary the CO<sub>2</sub> concentrations for these periods as well. The duration of the simulations is 15 years, and the spatial resolution is 2 degrees. We use passive tracers to study the geographical sources of water. Surface evaporation from predetermined continental and oceanic regions provides the source of water for each passive tracer. In this way, we compute the percent of precipitation of each region over the globe. This can also be used to estimate precipitation recycling. In addition, we are using the passive tracers to independently compute the global cycling of water (compared to the traditional, Q/P calculation).

Author

*Numerical Analysis; Hydrological Cycle; Sea Surface Temperature; Carbon Dioxide Concentration; Computerized Simulation*

**20030020820** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Sensitivity of Precipitation Processes to Microphysics and Resolution in a Cloud-Resolving Model**

Tao, Wei-Kao; [2003]; 1 pp.; In English; Heavy Rain Workshop, 4-6 Feb. 2003, Tokyo, Japan; No Copyright; Avail: Other Sources; Abstract Only

The Goddard Cumulus Ensemble (GCE) model is used to examine the impact of various microphysical schemes, and vertical and horizontal resolution on the development, intensity and rainfall associated with mesoscale convective systems, idealized hurricanes and an ensemble of clouds. The model variables include horizontal and vertical velocities, potential temperature, perturbation pressure, turbulent kinetic energy, and mixing ratios of all water phases (vapor, liquid, and ice). The major characteristics of the GCE model are the explicit representation of warm rain and ice microphysical processes, and their complex interactions with solar and infrared radiative transfer processes, and with surface processes. For idealized hurricane, an axisymmetric version of the GCE model was developed and used successfully to simulate the tropical cyclogenesis process using both a Rankin vortex and saturated air within a specified radius as initial conditions. For mesoscale convective systems, the 3-D version of the GCE model was used to simulate squall lines that developed in the western Pacific, South China Sea, eastern Atlantic, South America and central U.S. For the cloud ensemble, the GCE model was integrated for several days in order to have good sampling of cloud statistics. In this paper, the sensitivities of hurricane intensity to various microphysical processes and model grid resolution will be examined. This will be mainly achieved by performing sensitivity tests using various horizontal (from 1- to 5-kilometers) and vertical resolutions (from 20- to 200-meters in the lower troposphere to 200- to 500-m in the middle and upper troposphere). Sensitivity tests using various microphysical schemes (warm rain only, and three ice with either graupel or hail) will also be performed. The PBL and diurnal variation of precipitation processes will also be evaluated. The budgets will be calculated for different regions (i.e., convective and stratiform regions).

Author

*Cumulus Clouds; Precipitation (Meteorology); Atmospheric Models; Sensitivity Analysis; Mesoscale Phenomena; Spatial Resolution; Free Convection*



**20030020822** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Cloud Modeling Using Field Project Data for the Study of Precipitation Processes**

Tao, W.-K.; Shie, C.-H.; Lang, S.; Simpson, J.; [2003]; 2 pp.; In English; IUGG/IaMAS, 30 Jun. - 11 Jul. 2003, Sapporo, Japan; No Copyright; Avail: Other Sources; Abstract Only

The use of cloud-resolving models (CRMs) in the study of precipitation process and their relation to the large-scale environment can be generally categorized into two approaches. The first approach is so called 'cloud ensemble modeling'. In this approach, many clouds of different size in various stages of their lifecycles can be present at any model simulation time. Large-scale effects are derived from observations and imposed into the model as the main forcing. The advantage of this approach is that the modeled convection will be forced to have the same intensity, thermodynamic budget and organization as the observations. This approach will also allow CRMs to perform multi-day or multi-week time integrations. The second approach usually requires initial temperature and water vapor profiles that have a medium to large CAPE, and open lateral boundary conditions are used. The modeled clouds could be termed 'self-forced convection'. Model improvements, such as in the microphysics, are achieved using the second approach. In cloud ensemble modeling, accurate large-scale advective tendencies for temperature and water vapor are the main forcing for the CRMs. We found that the large-scale advective terms for temperature and water vapor are not always consistent. For example, large-scale forcing could indicate strong drying which would produce cooling in the model through evaporation but not contain large-scale advective heating to compensate. This discrepancy in forcing would cause differences between the observed and modeled latent heating profiles. Good measurements of other quantities (i.e., surface fluxes and radiation) are also required to perform variational objective analysis that computes and minimizes a 'cost function' that constrains the difference between the large-scale advective forcing in temperature and water vapor. With self-forced convection, accurate vertical distributions of temperature, moisture (water vapor), and horizontal winds are required. The timing of the measurements relative to cloud development is crucial (i.e., prior to cloud triggering). Microphysical measurements (i.e., the cloud number concentration and size distribution) can also be used in this second approach but are of secondary importance with cloud ensemble modeling. In this paper, data collected during TRMM field campaigns (FCs; i.e., SCSMEX, LBA and KWAJEX) which were aimed at validating TRMM products (i.e., rainfall and the vertical distribution of latent heating) will be used to examine the impact of errors in the initial conditions (e.g., soundings and large-scale forcing) on simulated rainfall distributions and brightness. Rainfall and precipitations simulated from a CRM will also be compared with those estimated by a stochastic model.

Author

*Atmospheric Moisture; Free Convection; Atmospheric Heating; Computerized Simulation; Boundary Conditions; Temperature Profiles; Thermodynamics; Clouds (Meteorology)*

**20030020845** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Tropical Tropospheric Ozone from SHADOZ (Southern Hemisphere Additional Ozonesondes) Network: A Project for Satellite Research, Process Studies, Education**

Thompson, Anne M.; Witte, Jacquelyn C.; Oltmans, Samuel J.; Schmidlin, Francis J.; Coetzee, G. J. R.; Hoegger, Bruno; Kirchhoff, V. W. J. H.; Ogawa, Toshihiro; Kawakami, Shuji; Posny, Francoise, et al.; [2002]; 2 pp.; In English; Joint CACGP/IGAC2002 Symposium, 18-25 Sep. 2002, Heraklion, Greece; No Copyright; Avail: Other Sources; Abstract Only

The first climatological overview of total, stratospheric and tropospheric ozone in the southern hemisphere tropical and subtropics is based on ozone sounding data from 10 sites comprising the Southern Hemisphere Additional OZonesondes (SHADOZ) network. The period covered is 1998-2000. Observations were made over: Ascension Island; Nairobi, Kenya; Irene, South Africa; Reunion Island; Watukosek, Java; Fiji; Tahiti; American Samoa; San Cristobal, Galapagos; Natal, Brazil. Campaign data were collected on a trans-Atlantic oceanographic cruise and during SAFARI-2000 in Zambia. The ozone data, with simultaneous temperature profiles to approx. 7 hPa and relative humidity to approx. 200 hPa, reside at: <[http://code916.gsfc.nasa.gov/Data\\_services/shadoz](http://code916.gsfc.nasa.gov/Data_services/shadoz)>. SHADOZ ozone time-series and profiles give a perspective on tropical total, stratospheric and tropospheric ozone. Prominent features are highly variable tropospheric ozone and a zonal wave-one pattern in total (and tropospheric) column ozone. Total, stratospheric and tropospheric column ozone amounts peak between August and November and are lowest between March and May. Tropospheric ozone variability over the Indian and Pacific Ocean displays influences of the Indian Ocean Dipole and convective mixing. Pollution transport from Africa and South America is a seasonal feature. Tropospheric ozone seasonality over the Atlantic Basin shows effects of regional subsidence and recirculation as well as biomass burning. Dynamical and chemical influences appear to be of comparable magnitude though model studies are needed to quantify this.

Author

*Atmospheric Composition; Tropical Regions; Troposphere; Stratosphere; Atmospheric Sounding; Ozone Depletion*



## OCEANOGRAPHY

Includes the physical, chemical and biological aspects of oceans and seas; ocean dynamics; and marine resources. For related information see also *43 Earth Resources and Remote Sensing*.

**20030020844** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**The IERS Special Bureau for Tides**

Ray, Richard D.; Chao, B. F.; Desai, S. D.; [2002]; 1 pp.; In English; IERS Workshop on Combination Research and Global Geophysical Fluids, 18-21 Nov. 2002, Munich, Germany; No Copyright; Avail: Other Sources; Abstract Only

The Global Geophysical Fluids Center of the International Earth Rotation Service (IERS) comprises 8 special bureaus, one of which is the Special Bureau for Tides. Its purpose is to facilitate studies related to tidal effects in earth rotation. To that end it collects various relevant datasets and distributes them, primarily through its website at [bowie.gsfc.nasa.gov/ggfc/tides](http://bowie.gsfc.nasa.gov/ggfc/tides). Example datasets include tabulations of tidal variations in angular momentum and in earth rotation as estimated from numerical ocean tide models and from meteorological reanalysis products. The web site also features an interactive tidal prediction 'machine' which generates tidal predictions (e.g., of UT1) from lists of harmonic constants. The Special Bureau relies on the tidal and earth-rotation communities to build and enlarge its datasets; further contributions from this community are most welcome.

Author

*Tides; Earth Rotation; Geophysical Fluids; Ocean Models; Angular Momentum*

## BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**20030020673** Defence Science and Technology Organisation, Edinburgh, Australia

**A Virtual Information-action Workspace**

Lintern, Gavan; Naikar, Neelam; October 2002; 23 pp.; In English

Report No.(s): DSTO-TR-1365; DODA-AR-012-493; Copyright; Avail: Other Sources

Rapid technological development is a hallmark of modern life. Innovation has come in the form of more information at higher rates, of different forms, at shorter delays and from a wider range of resources. Those working with these innovations have had to adjust as best they can to many of the new demands. The emerging problem is one of information management. Now the forces of a competitive environment are forcing us to do something about it. The development of virtual information-action workspaces offers one opportunity to do things differently. The goal is to organize our information so that we can act on it effectively. That requires an understanding of the information each and everyone of us needs to do our job, the desirable form, level of abstraction and organization of that information, and the action modes that are needed to respond to it. Diverse analytic and design tools to accomplish these goals are available within the behavioural sciences. The development of a virtual information-action workspace requires a coordinated effort to apply those tools in a systematic manner. The virtual information-action workspace offers a solution to a problem that will only become more severe unless we resolve it.

Author

*Information Systems; Information Management; Military Operations; Virtual Reality; Human-Computer Interface; Telecommunication; Decision Making*

## MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human factors engineering, bionics, man-machine systems, life support, space suits and protective clothing. For related information see also *16 Space Transportation and Safety* and *52 Aerospace Medicine*.

**20030020649** NASA Langley Research Center, Hampton, VA, USA

**Team-Centered Perspective for Adaptive Automation Design**

Prinzel, Lawrence J., III; February 2003; 27 pp.; In English

Contract(s)/Grant(s): RTOP 727-05-50-01

Report No.(s): NASA/TM-2003-212154; L-18266; NAS 1.15:212154; No Copyright; Avail: CASI; [A03](#), Hardcopy

Automation represents a very active area of human factors research. The journal, *Human Factors*, published a special issue on automation in 1985. Since then, hundreds of scientific studies have been published examining the nature of automation and its interaction with human performance. However, despite a dramatic increase in research investigating human factors issues in aviation automation, there remain areas that need further exploration. This NASA Technical Memorandum describes a new area of automation design and research, called adaptive automation. It discusses the concepts and outlines the human factors issues associated with the new method of adaptive function allocation. The primary focus is on human-centered design, and specifically on ensuring that adaptive automation is from a team-centered perspective. The document shows that adaptive automation has many human factors issues common to traditional automation design. Much like the introduction of other new technologies and paradigm shifts, adaptive automation presents an opportunity to remediate current problems but poses new ones for human-automation interaction in aerospace operations. The review here is intended to communicate the philosophical perspective and direction of adaptive automation research conducted under the Aerospace Operations Systems (AOS), Physiological and Psychological Stressors and Factors (PPSF) project.

Author

*Human Factors Engineering; Automation; Design Analysis; Teams; Aircraft Design; Aerospace Systems*

**20030020720** DYNACS Engineering Co., Inc., Cocoa Beach, FL, USA

**Human Factors Process Task Analysis Liquid Oxygen Pump Acceptance Test Procedure for the Advanced Technology Development Center**

Diorio, Kimberly A.; [2002]; 28 pp.; In English; Society of Women Engineers, 8 Oct. 2002, Daytona Beach, FL., USA  
Contract(s)/Grant(s): NAS10-98001

Report No.(s): KSC-2002-117; KSC-YA-6040; No Copyright; Avail: CASI; [A03](#), Hardcopy

A process task analysis effort was undertaken by Dynacs Inc. commencing in June 2002 under contract from NASA YA-D6. Funding was provided through NASA's Ames Research Center (ARC), Code M/HQ, and Industrial Engineering and Safety (IES). The John F. Kennedy Space Center (KSC) Engineering Development Contract (EDC) Task Order was 5SMA768. The scope of the effort was to conduct a Human Factors Process Failure Modes and Effects Analysis (HF PFMEA) of a hazardous activity and provide recommendations to eliminate or reduce the effects of errors caused by human factors. The Liquid Oxygen (LOX) Pump Acceptance Test Procedure (ATP) was selected for this analysis. The HF PFMEA table (see appendix A) provides an analysis of six major categories evaluated for this study. These categories include Personnel Certification, Test Procedure Format, Test Procedure Safety Controls, Test Article Data, Instrumentation, and Voice Communication. For each specific requirement listed in appendix A, the following topics were addressed: Requirement, Potential Human Error, Performance-Shaping Factors, Potential Effects of the Error, Barriers and Controls, Risk Priority Numbers, and Recommended Actions. This report summarizes findings and gives recommendations as determined by the data contained in appendix A. It also includes a discussion of technology barriers and challenges to performing task analyses, as well as lessons learned. The HF PFMEA table in appendix A recommends the use of accepted and required safety criteria in order to reduce the risk of human error. The items with the highest risk priority numbers should receive the greatest amount of consideration. Implementation of the recommendations will result in a safer operation for all personnel.

Author

*Human Factors Engineering; Human Performance; Failure Modes; Hazards; Safety Management; Tasks*

## 60

### COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware and data processing. For components see *33 Electronics and Electrical Engineering*. For computer vision see *63 Cybernetics, Artificial Intelligence and Robotics*.

**20030020658** Defence Science and Technology Organisation, Edinburgh, Australia

**An Automated Method of Facilitating Analysis of Voice Communications**

Clark, Philip G.; Dickinson, Rowland E.; November 2002; 21 pp.; In English

Report No.(s): DSTO-TN-0447; DODA-AR-012-410; Copyright; Avail: Other Sources

DSTO has historically gathered voice communications data for analysis. Preparing this data for analysis is very time intensive and in many cases cannot be undertaken due to resource constraints. This paper describes a simple computer tool to automatically log and compress live communications activity or previously tape recorded analogue information. The tool

presents this information in a form ready for immediate computer based analysis.

Author

*Voice Communication; Computer Techniques; Voice Data Processing*

**20030020768** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Standards-and Component-Based Mission Operations Architecture at NASA's Goddard Space Flight Center**

Smith, Danford; March 06, 2003; 8 pp.; In English; Ground System Architecture Workshop, 4-6 Mar. 2003, Manhattan Beach, CA, USA; Original contains black and white illustrations; No Copyright; Avail: CASI; [A02](#), Hardcopy

NASA Goddard Space Flight Center (GSFC) manages many of NASA's earth and space science satellite missions. A wide variety of commercial products and GSFC-developed software components are typically integrated into a unique system configuration for each mission. Independent development of the many mission operations center systems has led to systems that are expensive to integrate, difficult to infuse with new capabilities developed for other programs, and cumbersome to maintain. This traditional approach becomes even more problematic as NASA moves towards satellite constellations, new operations concepts, and even further budgets reductions. The GSFC Mission Services Evolution Center (GMSEC) is creating a new architecture for future missions at GSFC. Instead of selecting the best-in-class components and creating a standard control center system, GMSEC is developing component interface standards so that multiple products can plug-and-play into the configuration. Missions can then select the best components based on the merits of the product and not simply based on recent integration history at NASA. The GMSEC system utilizes a publish/subscribe information bus and standard XML-based key message interfaces. Functional components can either match directly to the interface standard, or adapters can be developed to match the product's interface to the GMSEC standard without impacting the source product. Applications Program Interfaces (API's) are being developed to isolate the underlying middleware from the applications software and to allow the middleware product to be switched if necessary. Interface Control Documents (ICDs) between each pair of communicating components is replaced by a single message/API specification document. New applications must simply match to the information bus standards and need not worry about all of the other applications in the system. For legacy software, adapters can be developed to facilitate communications between the application and the information bus. As the approach has matured, it has become apparent that it can provide innovative solutions to some of the multi-satellite challenges facing GSFC.

Author

*NASA Space Programs; Flight Operations; Systems Engineering; Mission Planning; Architecture (Computers)*

## 61

### COMPUTER PROGRAMMING AND SOFTWARE

Includes software engineering, computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM. For computer software applied to specific applications, see also the associated category.

**20030020665** Defence Science and Technology Organisation, Edinburgh, Australia

**Situation Description Language Implementation**

Greenhill, S.; Venkatesh, S.; Pearce, A.; Ly, T. C.; November 2002; 52 pp.; In English

Report No.(s): DSTO-GD-0342; DODA-AR-012-486; Copyright; Avail: Other Sources

SDL is a Situation Description Language intended for use in situation assessment problems. SDL provides knowledge modelling and inference facilities for reasoning with information. This document describes a portable implementation of SDL in Java. It provides information required by a user of the system. Details include the operation of the compiler, the use of temporal knowledge and inference, and use of the visualisation system. This report also provides implementation details necessary for modifying or extending the system. A detailed example describes how the system was used for submarine situation assessment.

Author

*Situational Awareness; Expert Systems; Java (Programming Language); Scientific Visualization; Knowledge Bases (Artificial Intelligence)*

**20030020671** Minnesota Univ., Minneapolis, MN, USA

**Test-Case Generation using an Explicit State Model Checker Final Report**

Heimdahl, Mats P. E.; Gao, Jimin; March 07, 2003; 41 pp.; In English

Contract(s)/Grant(s): NCC2-1335; No Copyright; Avail: CASI; [A03](#), Hardcopy

In the project ‘Test-Case Generation using an Explicit State Model Checker’ we have extended an existing tools infrastructure for formal modeling to export Java code so that we can use the NASA Ames tool Java Pathfinder (JPF) for test case generation. We have completed a translator from our source language RSML(exp -e) to Java and conducted initial studies of how JPF can be used as a testing tool. In this final report, we provide a detailed description of the translation approach as implemented in our tools.

Author

*Software Engineering; Software Reliability; Computer Programs; Program Verification (Computers); Systems Analysis; Computer Systems Performance; Formalism*

**20030020774** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Sensor Web Architectural Concepts and Implementation Challenges - An Heuristic Approach**

Habib, Shahid; Hildebrand, Peter; April 11, 2002; 1 pp.; In English; SPIE International Symposium on Remote Sensing, 22-27 Sep. 2002, Crete, Greece; No Copyright; Avail: Other Sources; Abstract Only

There is a significant interest in the Earth Science remote sensing community to increase the number of observations. The obvious reasons for such a push is to improve the temporal and surface coverage of measurements. However, there is little analysis available in terms of benefits, costs and optimized set of sensors needed to make these necessary observations. In reality, this is a complex problem that should be carefully studied and balanced over many boundaries. For example, the question of technology maturity versus users desire to obtain additional measurements is non congruent. This is further complicated by the limitations of the laws of physics and the economic conditions. With the advent of advance technology, it is anticipated that the cost of the spacecraft technology will become more affordable. However, the specialized detector subsystems, and the precision flying techniques may still require substantial innovation, development time and cost. Additionally, the space deployment scheme should also be given a careful attention because of a high expense. Nonetheless, it is important to carefully examine the science priorities and steer the development efforts that can commensurate with the tangible requirements. This paper outlines a possible set of architectural concepts, operational scenarios and potential benefits of one scheme versus another. It further makes some suggestions where one can draw some boundary conditions to incrementally solve this predicament.

Author

*Architecture (Computers); Remote Sensing; Heuristic Methods; Boundary Conditions*

**20030020799** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**CRYSTAL, EOS Validation, and CAMEX-5**

Starr, David; [2002]; 1 pp.; In English; CAMEX-5 Workshop, Nov. 20-22, 2002, Huntsville, AL, USA; No Copyright; Avail: Other Sources; Abstract Only

CAMEX-5 is at an early phase of concept development. This future field deployment (2004 or 2005) concerning hurricanes could potentially benefit from collaboration with other programs within NASA. Specifically, the recently completed CRYSTAL- Florida Area Cirrus Experiment (FACE) offers a useful model of such a collaborative endeavor. CRYSTAL-FACE was concerned with deep tropical convection and its impact on the upper troposphere. Three separate NASA R&A Programs joined in supporting CRYSTAL-FACE, including the Radiation Sciences Program, the Atmospheric Chemistry, Modeling & Analysis Program, and the Upper Atmosphere Research Program as well as the EOS Validation Program. In addition, the National Science Foundation and the Department of Energy Atmospheric Measurements Programs were also substantive partners. Insights will be given into how this cooperative field experiment came to be and how it worked in the field. Possibilities for similar model for CAMEX-5 will be explored.

Author

*Earth Observing System (Eos); Crystals; Tropical Regions; Hurricanes; Atmospheric Chemistry; Computer Programs*

**63**

**CYBERNETICS, ARTIFICIAL INTELLIGENCE AND ROBOTICS**

Includes feedback and control theory, information theory, machine learning, and expert systems. For related information see also 54 *Man/System Technology and Life Support*.

**20030020722** NASA Ames Research Center, Moffett Field, CA, USA

**Demonstration of a Spoken Dialogue Interface for Planning Activities of a Semi-autonomous Robot**

Dowding, John; Frank, Jeremy; Hockey, Beth Ann; Jonsson, Ari; Aist, Gregory; January 2002; 2 pp.; In English; Human Language Technology 2002 Conference; No Copyright; Avail: CASI

Planning and scheduling in the face of uncertainty and change pushes the capabilities of both planning and dialogue technologies by requiring complex negotiation to arrive at a workable plan. Planning for use of semi-autonomous robots involves negotiation among multiple participants with competing scientific and engineering goals to co-construct a complex plan. In NASA applications this plan construction is done under severe time pressure so having a dialogue interface to the plan construction tools can aid rapid completion of the process. But, this will put significant demands on spoken dialogue technology, particularly in the areas of dialogue management and generation. The dialogue interface will need to be able to handle the complex dialogue strategies that occur in negotiation dialogues, including hypotheticals and revisions, and the generation component will require an ability to summarize complex plans. This demonstration will describe a work in progress towards building a spoken dialogue interface to the EUROPA planner for the purposes of planning and scheduling the activities of a semi-autonomous robot. A prototype interface has been built for planning the schedule of the Personal Satellite Assistant (PSA), a mobile robot designed for micro-gravity environments that is intended for use on the Space Shuttle and International Space Station. The spoken dialogue interface gives the user the capability to ask for a description of the plan, ask specific questions about the plan, and update or modify the plan. We anticipate that a spoken dialogue interface to the planner will provide a natural augmentation or alternative to the visualization interface, in situations in which the user needs very targeted information about the plan, in situations where natural language can express complex ideas more concisely than GUI actions, or in situations in which a graphical user interface is not appropriate.

Author

*Task Planning (Robotics); Programming (Scheduling); Speech Recognition; Robot Control; Control Systems Design; Natural Language (Computers)*

## 64

### NUMERICAL ANALYSIS

Includes iteration, differential and difference equations, and numerical approximation.

**20030020747** Ohio Aerospace Inst., Cleveland, OH, USA

#### **A Localized Tau Method PDE Solver**

Cottam, Russell; [2002]; 23 pp.; In English; American Physical Society: Division of Computational Physics Conference, 24-28 Aug. 2002, San Diego, CA, USA

Contract(s)/Grant(s): NCC3-799; RTOP 755-A4-05; No Copyright; Avail: CASI; [A03](#), Hardcopy

In this paper we present a new form of the collocation method that allows one to find very accurate solutions to time marching problems without the unwelcome appearance of Gibbs's phenomenon oscillations. The basic method is applicable to any partial differential equation whose solution is a continuous, albeit possibly rapidly varying function. Discontinuous functions are dealt with by replacing the function in a small neighborhood of the discontinuity with a spline that smoothly connects the function segments on either side of the discontinuity. This will be demonstrated when the solution to the inviscid Burgers equation is discussed.

Derived from text

*Collocation; Partial Differential Equations; Discontinuity; Predictor-Corrector Methods; Numerical Analysis*

**20030020850** NASA Goddard Space Flight Center, Greenbelt, MD, USA

#### **On the Singularity in the Estimation of the Quaternion-of-Rotation**

Bar-Itzhack, Itzhack Y.; Thienel, Julie K.; [2003]; 30 pp.; In English; Copyright; Avail: CASI; [A03](#), Hardcopy

It has been claimed in the archival literature that the covariance matrix of a Kalman filter, which is designed to estimate the quaternion-of-rotation, is necessarily rank deficient because the normality constraint of the quaternion produces dependence between the quaternion elements. In reality, though, this phenomenon does not occur. The covariance matrix is not singular, and the filter is well behaved. Several simple examples are presented that demonstrate the regularity of the covariance matrix. First, estimation cases are presented where a relationship exists between the estimated variables, and yet the covariance matrix is not singular. Then the particular problem of quaternion estimation is analyzed. It is shown that the discrepancy stems from the fact that a functional relationship exists between the elements of the true quaternion but not between its estimated elements.

Author

*Singularity (Mathematics); Quaternions; Kalman Filters; Covariance; Rotation; Attitude (Inclination); Parameterization*



## STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; time series analysis; and stochastic processes.

**20030020790** NASA Ames Research Center, Moffett Field, CA, USA

### Finite Volume Methods: Foundation and Analysis

Barth, Timothy; Ohlberger, Mario; January 2003; 57 pp.; In English; Copyright; Avail: CASI; [A04](#), Hardcopy

Finite volume methods are a class of discretization schemes that have proven highly successful in approximating the solution of a wide variety of conservation law systems. They are extensively used in fluid mechanics, porous media flow, meteorology, electromagnetics, models of biological processes, semi-conductor device simulation and many other engineering areas governed by conservative systems that can be written in integral control volume form. This article reviews elements of the foundation and analysis of modern finite volume methods. The primary advantages of these methods are numerical robustness through the obtention of discrete maximum (minimum) principles, applicability on very general unstructured meshes, and the intrinsic local conservation properties of the resulting schemes. Throughout this article, specific attention is given to scalar nonlinear hyperbolic conservation laws and the development of high order accurate schemes for discretizing them. A key tool in the design and analysis of finite volume schemes suitable for non-oscillatory discontinuity capturing is discrete maximum principle analysis. A number of building blocks used in the development of numerical schemes possessing local discrete maximum principles are reviewed in one and several space dimensions, e.g. monotone fluxes, E-fluxes, TVD discretization, non-oscillatory reconstruction, slope limiters, positive coefficient schemes, etc. When available, theoretical results concerning a priori and a posteriori error estimates are given. Further advanced topics are then considered such as high order time integration, discretization of diffusion terms and the extension to systems of nonlinear conservation laws.

Author

*Finite Volume Method; Conservation Laws; Maximum Principle; Tvd Schemes; Nonoscillatory Action; Approximation; Unstructured Grids (Mathematics)*

## SYSTEMS ANALYSIS AND OPERATIONS RESEARCH

Includes mathematical modeling of systems; network analysis; mathematical programming; decision theory; and game theory.

**20030020854** NASA Ames Research Center, Moffett Field, CA, USA

### Tractable Pareto Optimization of Temporal Preferences

Morris, Robert; Morris, Paul; Khatib, Lina; Venable, Brent; [2003]; 7 pp.; In English; IJCAI '03 Report No.(s): Paper-359; Copyright; Avail: CASI; [A02](#), Hardcopy

This paper focuses on temporal constraint problems where the objective is to optimize a set of local preferences for when events occur. In previous work, a subclass of these problems has been formalized as a generalization of Temporal CSPs, and a tractable strategy for optimization has been proposed, where global optimality is defined as maximizing the minimum of the component preference values. This criterion for optimality, which we call 'Weakest Link Optimization' (WLO), is known to have limited practical usefulness because solutions are compared only on the basis of their worst value; thus, there is no requirement to improve the other values. To address this limitation, we introduce a new algorithm that re-applies WLO iteratively in a way that leads to improvement of all the values. We show the value of this strategy by proving that, with suitable preference functions, the resulting solutions are Pareto Optimal.

Author

*Algorithms; Optimization; Constraints; Events; Temporal Logic*

## ACOUSTICS

Includes sound generation, transmission, and attenuation. For noise pollution see *45 Environment Pollution*. For aircraft noise see also *02 Aerodynamics* and *07 Aircraft Propulsion and Power*.

**20030020847** Florida State Univ., Tallahassee, FL, USA

### Advanced Computational Aeroacoustics Methods for Fan Noise Prediction

Envia, Edmane, Technical Monitor; Tam, Christopher; [2003]; 7 pp.; In English Contract(s)/Grant(s): NAG3-2327; No Copyright; Avail: CASI; [A02](#), Hardcopy

Direct computation of fan noise is presently not possible. One of the major difficulties is the geometrical complexity of the problem. In the case of fan noise, the blade geometry is critical to the loading on the blade and hence the intensity of the radiated noise. The precise geometry must be incorporated into the computation. In computational fluid dynamics (CFD), there are two general ways to handle problems with complex geometry. One way is to use unstructured grids. The other is to use body fitted overset grids. In the overset grid method, accurate data transfer is of utmost importance. For acoustic computation, it is not clear that the currently used data transfer methods are sufficiently accurate as not to contaminate the very small amplitude acoustic disturbances. In CFD, low order schemes are, invariably, used in conjunction with unstructured grids. However, low order schemes are known to be numerically dispersive and dissipative. dissipative errors are extremely undesirable for acoustic wave problems. The objective of this project is to develop a high order unstructured grid Dispersion-Relation-Preserving (DRP) scheme. would minimize numerical dispersion and dissipation errors. contains the results of the funded portion of the project. scheme on an unstructured grid has been developed. constructed in the wave number space. The characteristics of the scheme can be improved by the inclusion of additional constraints. Stability of the scheme has been investigated. Stability can be improved by adopting the upwinding strategy.

Author

*Aeroacoustics; Computational Fluid Dynamics; Fan Blades; Noise Prediction; Jet Engines*

## 72

### ATOMIC AND MOLECULAR PHYSICS

Includes atomic and molecular structure, electron properties, and atomic and molecular spectra. For elementary particle physics see *73 Nuclear Physics*.

**20030020760** NASA Marshall Space Flight Center, Huntsville, AL, USA

#### **An Experimental Investigation To Determine Interaction Between Rotating Bodies**

Grugel, R. N.; Volz, M. P.; Mazuruk, K.; February 2003; 40 pp.; In English

Contract(s)/Grant(s): RTOP 279-00-16

Report No.(s): NASA/TM-2003-212286; M-1065; NAS 1.15:212286; Copyright; Avail: CASI; [A03](#), Hardcopy

A brass (copper+zinc) wheel, with a 4-in diameter and 1.4 in thick, was used for this investigation. Ceramic ball bearings were used to safely spin the wheel up to 40,000 rpm. The wheel was also electrically insulated from the rest of the armature. For spinning, an air turbine was used. The rotational velocity was measured by two methods: (1) A simple strobe light and (2) a photodiode that detected laser beam pulses as they passed through a slot in the rotating shaft. The magnetic sensor is based on a giant magnetoresistivity, and consists of a balanced bridge circuitry. The position of the sensor was as close as possible to the rim of the wheel. The linear dimension of the sensor is approximately equal to 8 mm so that the offset from the surface is on the order of 15 percent. We did not use any goniometer system, so the accuracy of the angular position is not high, being estimated within a few degrees, with the main uncertainty being the direction of Earth's magnetic field. We attempted to fit the experimental data with the presented theory by selecting the best value for the electrical conductivity of the wheel. The results of this procedure are displayed, where the black dots represent experimental values. A slight misfit on the right shoulder can be due to slight angular misalignment from a 90 degree position. The obtained value for the resistivity is 43 n(OMEGA)m, which compares well with those listed. We can conclude, based on these measurements, that the proposed theory satisfactorily explains our experiments.

Derived from text

*Rotating Bodies; Magnetoresistivity; Magnetic Fields; Faraday Effect; Mathematical Models; Numerical Analysis*

## 74

### OPTICS

Includes light phenomena and the theory of optical devices; for specific optical devices see also *35 Instrumentation and Photography*. For lasers see *36 Lasers and Masers*.

**20030020625** NASA Goddard Space Flight Center, Greenbelt, MD, USA

#### **A Nonlinear Observer for Gyro Alignment Estimation**

Thienel, J.; Sanner, R. M.; [2003]; 10 pp.; In English; AAs Guidance and Control Conference, 5-9 Feb. 2003, Breckenridge, CO., USA; Copyright; Avail: CASI; [A02](#), Hardcopy

A nonlinear observer for gyro alignment estimation is presented. The observer is composed of two error terms, an attitude

error and an alignment error. The observer is globally stable with exponential convergence of the attitude errors. The gyro alignment estimate converges to the true alignment when the system is completely observable.

Author

*Observation; Nonlinearity; Gyroscopes; Alignment*

**20030020630** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Automated Figuring and Polishing of Replication Mandrels for X-Ray Telescopes**

Krebs, Carolyn, Technical Monitor; Content, David; Fleetwood, Charles; Wright, Geraldine; Arsenovic, Petar; Collela, David; Kolos, Linette; May 2003; 1 pp.; In English; SPIE Optifab, 19-22 May 2003, Rochester, NY, USA; No Copyright; Avail: CASI; [A01](#), Hardcopy

In support of the Constellation X mission the Optics Branch at Goddard Space Flight Center is developing technology for precision figuring and polishing of mandrels used to produce replicated mirrors that will be used in X-Ray telescopes. Employing a specially built machine controlled in 2 axes by a computer, we are doing automated polishing/figuring of 15 cm long, 20 cm diameter cylindrical, conical and Wolter mandrels. A battery of tests allow us to fully characterize all important aspects of the mandrels, including surface figure and finish, mid-frequency errors, diameters and cone angle. Parts are currently being produced with surface roughnesses at the .5nm RMS level, and half-power diameter slope error less than 2 arcseconds.

Author

*Mandrels; Polishing; Mirrors; Surface Finishing; Computer Aided Manufacturing*

**20030020749** NASA Glenn Research Center, Cleveland, OH, USA

**Continuous Beam Steering From A Segmented Liquid Crystal Optical Phased Array**

Pouch, John; Nguyen, Hung; Miranda, Felix; Titus, Charles M.; Bos, Philip J.; November 25, 2002; 33 pp.; In English Contract(s)/Grant(s): NAG3-2539; No Copyright; Avail: CASI; [A03](#), Hardcopy

Optical communications to and from deep space probes will require beams possessing divergence on the order of a microradian, and must be steered with sub-microradian precision. Segmented liquid crystal spatial phase modulators, a type of optical phased array, are considered for this ultra-high resolution beam steering. It is shown here that in an ideal device of this type, there are ultimately no restrictions on the angular resolution. Computer simulations are used to obtain that result, and to analyze the influence of beam truncation and substrate flatness on the performance of this type of device.

Author

*Beam Steering; Liquid Crystals; Optical Communication; Phased Arrays; Computerized Simulation; Continuous Radiation*

**20030020787** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Development of High Resolution Hard X-Ray Telescope with Multilayer Coatings**

Gorenstein, Paul; Brinton, John C., Technical Monitor; March 2003; 4 pp.; In English Contract(s)/Grant(s): NAG5-5354; No Copyright; Avail: CASI; [A01](#), Hardcopy

The activities that occurred during the first year of the grant were: a) completed construction of the large multilayer deposition facility; b) Coated a large number of flat substrates and the interiors of cylindrical X-ray telescope shell substrates with uniform period and depth graded periods of tungsten-silicon (W/Is) bi-layers and other coatings; c) studied the influence of various factors affecting the quality of the multilayer coatings by measuring their reflection efficiency at 8 keV and higher energy X-rays.

Derived from text

*Coatings; Deposition; Silicon; Tungsten; X Ray Telescopes; Grazing Incidence Telescopes*

## 76 SOLID-STATE PHYSICS

Includes condensed matter physics, crystallography, and superconductivity. For related information see also *33 Electronics and Electrical Engineering*; and *36 Lasers and Masers*.

**20030020841** NASA Glenn Research Center, Cleveland, OH, USA

### **Growth of Defect-Free 3C-SiC on 4H- and 6H-SiC Mesas Using Step-Free Surface Heteroepitaxy**

Neudeck, Philip G.; Powell, J. Anthony; Trunek, Andrew J.; Huang, Xian-Rong R.; Dudley, Michael; Materials Science Forum; [2002]; Volumes 389-393, pp. 311-314; In English; International Conference on Silicon Carbide and Related Materials 2001, 28 Oct. - 2 Nov. 2001, Tsukuba, Japan

Contract(s)/Grant(s): YOM-2395; YOP-3472; RTOP 714-07-30

Report No.(s): E-13636; Copyright; Avail: Other Sources

A new growth process, herein named step-free surface heteroepitaxy, has achieved 3C-SiC films completely free of double positioning boundaries and stacking faults on 4H-SiC and 6H-SiC substrate mesas. The process is based upon the initial 2-dimensional nucleation and lateral expansion of a single island of 3C-SiC on a 4H- or 6H-SiC mesa surface that is completely free of bilayer surface steps. Our experimental results indicate that substrate-epilayer in-plane lattice mismatch ( $\Delta/a = 0.0854\%$  for 3C/4H) is at least partially relieved parallel to the interface in the initial bilayers of the heterofilm, producing an at least partially relaxed 3C-SiC film without dislocations that undesirably thread through the thickness of the epilayer. This result should enable realization of improved 3C-SiC devices.

Author

*Crystal Defects; Crystal Growth; Silicon Carbides; Epitaxy; Silicon Films; Nucleation*

## 77 PHYSICS OF ELEMENTARY PARTICLES AND FIELDS

Includes quantum mechanics; theoretical physics; and statistical mechanics. For related information see also *72 Atomic and Molecular Physics*, *73 Nuclear Physics*, and *25 Inorganic, Organic and Physical Chemistry*.

**20030020717** NASA Ames Research Center, Moffett Field, CA, USA

### **Time as an Observable in Nonrelativistic Quantum Mechanics**

Hahne, G. E.; January 2003; 37 pp.; In English; No Copyright; Avail: CASI; [A03](#), Hardcopy

The argument follows from the viewpoint that quantum mechanics is taken not in the usual form involving vectors and linear operators in Hilbert spaces, but as a boundary value problem for a special class of partial differential equations-in the present work, the nonrelativistic Schrodinger equation for motion of a structureless particle in four- dimensional space-time in the presence of a potential energy distribution that can be time-as well as space-dependent. The domain of interest is taken to be one of two semi-infinite boxes, one bounded by two  $t=\text{constant}$  planes and the other by two  $z=\text{constant}$  planes. Each gives rise to a characteristic boundary value problem: one in which the initial, input values on one  $t=\text{constant}$  wall are given, with zero asymptotic wavefunction values in all spatial directions, the output being the values on the second  $t=\text{constant}$  wall; the second with certain input values given on both  $z=\text{constant}$  walls, with zero asymptotic values in all directions involving time and the other spatial coordinates, the output being the complementary values on the  $z=\text{constant}$  walls. The first problem corresponds to ordinary quantum mechanics; the second, to a fully time-dependent version of a problem normally considered only for the steady state (time-independent Schrodinger equation). The second problem is formulated in detail. A conserved indefinite metric is associated with space-like propagation, where the sign of the norm of a unidirectional state corresponds to its spatial direction of travel.

Author

*Nonrelativistic Mechanics; Quantum Mechanics; Time Dependence; Wave Functions; Operators (Mathematics)*

## SOCIAL AND INFORMATION SCIENCES (GENERAL)

Includes general research topics related to sociology; educational programs and curricula. For specific topics in these areas see *categories 81 through 85*.

**20030020837** Space Telescope Science Inst., Baltimore, MD, USA

### **ISAIA: Interoperable Systems for Archival Information Access**

Hanisch, Robert J.; September 23, 2002; 5 pp.; In English

Contract(s)/Grant(s): NAG5-8629; STScI Proj. J0192; No Copyright; Avail: CASI; [A01](#), Hardcopy

The ISAIA project was originally proposed in 1999 as a successor to the informal AstroBrowse project. AstroBrowse, which provided a data location service for astronomical archives and catalogs, was a first step toward data system integration and interoperability. The goals of ISAIA were ambitious: ‘...To develop an interdisciplinary data location and integration service for space science. Building upon existing data services and communications protocols, this service will allow users to transparently query hundreds or thousands of WWW-based resources (catalogs, data, computational resources, bibliographic references, etc.) from a single interface. The service will collect responses from various resources and integrate them in a seamless fashion for display and manipulation by the user.’ Funding was approved only for a one-year pilot study, a decision that in retrospect was wise given the rapid changes in information technology in the past few years and the emergence of the Virtual Observatory initiatives in the US and worldwide. Indeed, the ISAIA pilot study was influential in shaping the science goals, system design, metadata standards, and technology choices for the virtual observatory. The ISAIA pilot project also helped to cement working relationships among the NASA data centers, US ground-based observatories, and international data centers. The ISAIA project was formed as a collaborative effort between thirteen institutions that provided data to astronomers, space physicists, and planetary scientists. Among the fruits we ultimately hoped would come from this project would be a central site on the Web that any space scientist could use to efficiently locate existing data relevant to a particular scientific question. Furthermore, we hoped that the needed technology would be general enough to allow smaller, more-focused community within space science could use the same technologies and standards to provide more specialized services. A major challenge to searching for data across a broad community is that information that describe some data products are either not relevant to other data or not applicable in the same way. Some previous metadata standard development efforts (e.g., in the earth science and library communities) have produced standards that are very large and difficult to support. To address this problem, we studied how a standard may be divided into separable pieces. Data providers that wish to participate in interoperable searches can support only those parts of the standard that are relevant to them. We prototyped a top-level metadata standard that was small and applicable to all space science data.

Author

*Data Management; Data Systems; Management Information Systems; Information Dissemination; Internet Resources; Information Transfer*

## DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography. For computer program documentation see *61 Computer Programming and Software*.

**20030020659** Defence Science and Technology Organisation, Edinburgh

### **A DIS Entity State PDU Generator**

Zalcman, Lucien; October 2002; 27 pp.; In English

Report No.(s): DSTO-TN-0460; DODA-AR-012-495; Copyright; Avail: Other Sources

The recent IITSEC 2001 Coalition Training Demonstration held between the US, Australian and Dutch Navies demonstrated a coalition training exercise using Advanced Distributed Simulation to simultaneously connect military training simulators in the USA, Australia and the Netherlands. Whilst participating in the setup and running of this exercise each nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such a coalition exercise, this paper discusses a proposal to make available to all participating coalition nations a Common Coalition Toolset (CCT) which comprises a set of software applications used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes a candidate CCT application - a DIS Entity State PDU Generator. This application was found to be extremely useful when setting up a



multiplayer Advanced Distributed Simulation such as the recent IITSEC 2001 Coalition Training Demonstration.

Author

*Distributed Interactive Simulation; Education; Military Technology; Programming Languages*

**20030020672** Defence Science and Technology Organisation, Fishermans Bend, Australia

**DSTO Maritime Platforms Division: External Interactions**

Box, Phillip; November 2002; 43 pp.; In English

Report No.(s): DSTO-GD-0345; DODA-AR-012-513; Copyright; Avail: Other Sources

DSTO Maritime Platforms Division's interactions with industry and academia have been recorded analyzed and are reported. The interactions are numerous and significant in scope and complexity. International interactions are also extensive covering a broad range of research areas across the Division.

Author

*Defense Program; International Cooperation; Australia; Government/Industry Relations*

**20030020744** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Development and Operations of the Astrophysics Data System**

Murray, Stephen S.; Oliversen, Ronald, Technical Monitor; March 2003; 36 pp.; In English

Contract(s)/Grant(s): NCC5-528

Report No.(s): Rept-2; No Copyright; Avail: CASI; [A03](#), Hardcopy

SAO TASKS ACCOMPLISHED: Abstract Service: (1) Continued regular updates of abstracts in the databases, both at SAO and at all mirror sites; (2) Established a new naming convention of QB books in preparation for adding physics books from Hollis or Library of Congress; (3) Modified handling of object tag so as not to interfere with XHTML definition; (4) Worked on moving 'what's new' announcements to a majordomo email list so as not to interfere with divisional mail handling; (5) Implemented and tested new first author feature following suggestions from users at the AAS meeting; (6) Added SSRv entries back to volume 1 in preparation for scanning of the journal; (7) Assisted in the re-configuration of the ADS mirror site at the CDS and sent a new set of tapes containing article data to allow re-creation of the ADS article data lost during the move; (8) Created scripts to automatically download Astrobiology.

Author

*Abstracts; Data Systems; Information Dissemination; Information Transfer; Astrophysics*

**20030020825** NASA Kennedy Space Center, Cocoa Beach, FL, USA

**Cryogenic Information Center**

Mohling, Robert A.; Marquardt, Eric D.; Fusilier, Fred C.; Fesmire, James E.; [2003]; 6 pp.; In English; 21st International Congress of Refrigeration, 17-22 Aug. 2003, Washington, D.C., USA

Report No.(s): KSC-2003-027; ICR-0633; Copyright; Avail: CASI; [A02](#), Hardcopy

The Cryogenic Information Center (CIC) is a not-for-profit corporation dedicated to preserving and distributing cryogenic information to government, industry, and academia. The heart of the CIC is a uniform source of cryogenic data including analyses, design, materials and processes, and test information traceable back to the Cryogenic Data Center of the former National Bureau of Standards. The electronic database is a national treasure containing over 146,000 specific bibliographic citations of cryogenic literature and thermophysical property data dating back to 1829. A new technical/bibliographic inquiry service can perform searches and technical analyses. The Cryogenic Material Properties (CMP) Program consists of computer codes using empirical equations to determine thermophysical material properties with emphasis on the 4-300K range. CMP's objective is to develop a user-friendly standard material property database using the best available data so government and industry can conduct more accurate analyses. The CIC serves to benefit researchers, engineers, and technologists in cryogenics and cryogenic engineering, whether they are new or experienced in the field.

Author

*Cryogenics; Data Bases; Information Systems; Information Retrieval; Information Transfer*

## SPACE SCIENCES (GENERAL)

Includes general research topics related to the natural space sciences. For specific topics in space sciences see *categories 89 through 93*.

**20030020650** NASA Marshall Space Flight Center, Huntsville, AL, USA

**B-MINE: The Balloon-Borne Microcalorimeter Nuclear Line Explorer**

Silver, E.; Schnopper, H.; Jones, C.; Forman, W.; Bandler, S.; Murray, S.; Romaine, S.; Slane, P.; Grindlay, J.; Madden, N., T; Proceedings of Gamma 2001; June 2001; 5 pp.; In English; Gamma 2001

Contract(s)/Grant(s): NAG5-5104; Copyright; Avail: CASI; [A01](#), Hardcopy

B-MINE is a concept for a balloon mission designed to probe the deepest regions of a supernova explosion by detecting  $^{44}\text{Ti}$  emission at 68 keV with spatial and spectral resolutions that are sufficient to determine the extent and velocity distribution of the  $^{44}\text{Ti}$  emitting region. The payload introduces the concept of focusing optics and microcalorimeter spectroscopy to nuclear line emission astrophysics. B-MINE has a thin, plastic foil telescope multilayered to maximize the reflectivity in a 20 keV band centered at 68 keV and a microcalorimeter array optimized for the same energy band. This combination provides a reduced background, an energy resolution of 50 eV and a 3 sigma sensitivity in 10 (exp 6) s of  $3.3 \times 10(\text{exp } -7) \text{ ph cm}(\text{exp } -2) \text{ s}(\text{exp } -1)$  at 68 keV. During the course of a long duration balloon flight, B-MINE could carry out a detailed study of the  $^{44}\text{Ti}$  emission line centroid and width in CAS A.

Author

*Balloons; Supernovae; Stellar Physics; Nuclear Radiation Spectroscopy; Calorimeters; Titanium*

## ASTRONOMY

Includes observations of celestial bodies; astronomical instruments and techniques; radio, gamma-ray, x-ray, ultraviolet, and infrared astronomy; and astrometry.

**20030020629** California Inst. of Tech., Pasadena, CA, USA

**[CII] 158 micron Absorption Line Towards the Galactic Center: Connection with Bright IR Galaxies**

Vastel, Charlotte; Polehampton, E.; Baluteau, J.-P.; Swinyard, B.; Caux, E.; Cox, P.; January 2002; 4 pp.; In English; Chemistry as a Diagnostic of Star Formation Conference, 21-23 Aug. 2002, Waterloo, Canada

Report No.(s): Rept-2002-9; Copyright; Avail: Other Sources

Located near the galactic center, Sgr B2 is one of the largest HII/molecular cloud complexes in the Galaxy. The total mass and compactness of Sgr B2 are comparable to those of the W49N star-forming complex. We studied the clouds along its line of sight with the help of Infrared Space Observatory (ISO)-Long-Wavelength Spectrometer (LWS) data combined to ground based molecular observation. A complete study can be found in Vastel et al. but we present here the fundamental results.

Author

*Galaxies; Line Spectra; Molecular Clouds; Interstellar Matter; Absorption Spectra; Infrared Astronomy*

**20030020637** Submillimeter Observatory, Hilo, HI, USA

**HCN Abundance Contrast in Warm Dense Cores of G1.6-0.025**

Peng, Ruisheng; Whiteoak, John B.; Houde, Martin; Yoshida, Hiroshige; 2002; 4 pp.; In English; Chemistry as a Diagnostic of Star Formation, 21-23 Aug. 2002, Waterloo, Canada

Report No.(s): Rept-2002-6; Copyright; Avail: Other Sources

We report a 5x contrast in HCN abundance between two warm dense cores of G1.6-0.025. The cores, at a LSR velocity of 145 km/s and 162 km/s respectively, are closely aligned along the line of sight with a size of approx. 2.5 pc and a typical FWHM line width of approx. 18 km/s. They also present very similar physical characteristics: core centers as probed by HCN lines have a gas density of approx.  $10(\text{exp } 7)/\text{cu cm}$  and a temperature of  $\geq 80 \text{ K}$ , while the outer peripheries seen in  $(13)\text{CO}$  lines is less dense (approx.  $10(\text{exp } 3)/\text{cu cm}$ ) at a temperature of 70-120 K. The contrast in HCN abundance between the two seemingly identical cores may indicate the 145 km/s core as a site of active star formation, whereby X-rays from the embedded

protostars maintain a higher rate of ionization leading to an enhanced HCN abundance in comparison with the more quiescent 162 km/s core.

Author

*Hydrocyanic Acid; Gas Density; Molecular Clouds; Spectrum Analysis; Interstellar Gas; Line Spectra; Emission Spectra*

**20030020752** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Origins of Solar Systems: Removing Activity-Related Radial Velocity Noise to Improve Extrasolar Planet Searches**

Saar, Steven; Lindstrom, David, Technical Monitor; February 2003; 4 pp.; In English

Contract(s)/Grant(s): NAG5-10630; No Copyright; Avail: CASI; [A01](#), Hardcopy

We have continued the super high resolution ( $R$  is approximately 200,000), high S/N ( $> 300$ ) echelle study of joint line bisector and radial velocity variations using the McDonald 2-D coude. A long observing run in October 2002 was quite successful (8 clear nights). We now have close to three years of data, which begins to sample a good fraction of the magnetic cycle timescales for some of our targets (e.g., K Ceti;  $P(\text{sub cyc})=5.6$  yrs). This will be very helpful in unraveling the complex relationships between plage and  $v(\text{sub } r)$ , changes which we have uncovered. A preliminary analysis of the limited data in hand, and find some tantalizing evidence for correlations between median line bisector displacement and radial velocity  $v(\text{sub } r)$ . The correlation appears to be specific to the particular star being considered, probably since it is a function of both spectral type and rotation rate. Additional information regarding progress on the grant is included.

Derived from text

*Radial Velocity; Noise Reduction; Solar System Evolution; Velocity Measurement; Extrasolar Planets*

**20030020754** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**A Synoptic Study Of An X-Ray Nova In Outburst (ADP 2000)**

McClintock, Jeffrey E.; Oliverson, Ronald J., Technical Monitor; February 2003; 2 pp.; In English

Contract(s)/Grant(s): NAG5-10813; No Copyright; Avail: CASI; [A01](#), Hardcopy

This grant is in support of an RXTE target-of-opportunity program (PI: J. McClintock) to study bright, black-hole X-ray novae. We request a second, one-year no-cost extension in order to (1) complete the study of X-ray nova 4U1543-47, which went into outburst on 2002 June 17, and (2) provide support during this work for Harvard graduate student Shinae Park who joined our team on 2003 February 10.

Author

*Black Holes (Astronomy); X Ray Timing Explorer; Novae; X Ray Astronomy; Data Processing*

**20030020766** Hawaii Univ., Honolulu, HI, USA

**Observations of Planet Crossing Asteroids**

Tholen, David J.; Whiteley, Robert J.; Lambert, Joy; Connelley, Michael; Salyk, Colette; [2002]; 8 pp.; In English

Contract(s)/Grant(s): NAG5-4524; No Copyright; Avail: CASI; [A02](#), Hardcopy

The goals of this research were the physical and dynamical characterization of planet crossing asteroids (Earth crossers, Mars crossers, Centaurs, and Pluto crossers, meaning trans-Neptunian objects), including colorimetry, rotational studies, and astrometry. Highlights are listed as follows: 1) Produced one doctoral dissertation (R. J. Whiteley, A Compositional and Dynamical Survey of the Near-Earth Asteroids). A key result is the fraction of Q-type asteroids among the near-Earth population was found to be about one-third; 2) Had predisccovery image showing the binary nature of trans-Neptunian object 1998 WW31, which is the first TNO to have a satellite found in orbit around it; 3) Discovery of shortest known rotation period for any asteroid (2000 D08, rotation period 78 seconds); it is just one of several fast-rotating small asteroids observed during the course of this project; 4) Discovery of a Centaur asteroid (1998 QM107) with, at the time, the smallest known orbital eccentricity among the Centaurs (0.13) and nearly in a 1:1 resonance with Uranus (semimajor axis of 19.9 AU); 5) Discovery of Apollo-type asteroid 1999 OW3, with a surprisingly bright absolute magnitude of 14.6 (estimated diameter of 4.6 km), brightest Apollo found in that calendar year; 6) Discovery of Aten-type asteroid 2000 SG344, which has the highest cumulative Earth impact probability among the near-Earth asteroids and a very Earth-similar orbit; 7) Instrumental in repairing the orbit of a numbered near-Earth asteroid for which predisccovery observations had been mis-attributed to it (2000 VN2); 8) Second-opposition recovery of 30-meter diameter Apollo-type asteroid 1998 KY26 in early 2002 when it was at a favorable magnitude of 24.8; 9) Primary contributor of astrometric observations of the CONTOUR fragments to the CONTOUR project following the failure of the spacecraft's kick motor; and 10) Development of orbit and ephemeris computation code that handles short observational arcs, observations at small solar elongations where indeterminacy is a known problem, and a small

number of observations (including just two). Starting in 2000 November, the Spaceguard Central Node began prioritizing near-Earth asteroids in need of astrometric observation. Our own follow-up efforts relied on these listings, with emphasis given to the faintest objects where the combination of a 2.2-m telescope and a site with subarcsecond seeing produces a limiting magnitude close to 25, which represents a unique and valuable capability. The attached table, last updated in August, demonstrates the arc-lengthening capabilities of a faint limiting magnitude. Tabulated are the arc lengths before and after our observation(s), whether our observation is the last one available for the object in question, and the approximate magnitude of the object at the time of the observation.

Author

*Asteroids; Astrometry; Orbit Calculation; Asteroid Detection; Planetary Orbits*

**20030020789** California Inst. of Tech., Pasadena, CA, USA

**Future MM/SUBMM Instrumentation and Science Opportunities: Example of Deuterated Molecules**

Phillips, Thomas G.; Vastel, Charlotte; [2002]; 11 pp.; In English; Chemistry as a Diagnostic of Star Formation, 21-23 Aug. 2003, Ontario, Canada

Contract(s)/Grant(s): NSF AST-99-80846; No Copyright; Avail: CASI; [A03](#), Hardcopy

During the next decade a tremendous advance will take place in instrumentation for spectroscopy of the interstellar medium. Major new facilities (ALMA, SOFIA, APEX, LMT, Herschel and others) will be constructed and commissioned, so that the science opportunities, in the field of astrochemistry, will increase by a huge factor. This will be enhanced by the new receivers with greater bandwidth and sensitivity. The new opportunities will be in the area of astrochemistry of distant objects, through greater sensitivity, or new spectral ranges due to the platforms above the Earth's atmosphere. Various aspects of new spectral ranges are discussed, with emphasis on H<sub>2</sub>O lines, features previously hidden under H<sub>2</sub>O or O<sub>2</sub> lines, light hydrides and particularly on deuterium in molecules. Recently, multiply deuterated species have been detected, e.g. ND<sub>3</sub>, in cold dense regions of the interstellar medium. It is argued here that it is possible that so much deuterium could be trapped, by the fractionation process, into heavy molecules such as ND<sub>3</sub>, etc ..., and species such as H<sub>2</sub>D(+) and possibly D<sub>2</sub>H(+), that D and HD might be depleted. This would be the mechanism for the large dispersion of [D]/[H] values found in the interstellar medium. Light molecules (hydrides and deuterides) generally have large fundamental rotation frequencies, often lying in the HIFI bands. The deuterides are a specially suitable case, because the species exist mainly in cold dense regions, where the molecules are in the ground states and THz observations will best be carried out by absorption spectroscopy against background dust continuum sources such as Sgr B2 and W49N.

Author

*Absorption Spectroscopy; Interstellar Chemistry; Deuterium Compounds; Submillimeter Waves; Satellite-Borne Instruments; Research And Development; Astronomical Observatories*

**20030020797** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Infrared Extinction and the Initial Conditions For Star and Planet Formation**

Lada, Charles J.; March 2003; 3 pp.; In English

Contract(s)/Grant(s): NAG5-9520; No Copyright; Avail: CASI; [A01](#), Hardcopy

This grant funds a research program to use infrared extinction measurements to probe the detailed structure of dark molecular clouds and investigate the physical conditions which give rise to star and planet formation. The goals of the this program are to: 1) acquire deep infrared and molecular-line observations of a carefully selected sample of nearby dark clouds, 2) reduce and analyze the data obtained in order to produce detailed extinction maps of the clouds, 3) prepare results, where appropriate, for publication.

Author

*Extinction; Far Infrared Radiation; Infrared Astronomy; Molecular Clouds; Planetary Evolution; Star Formation*

**20030020812** Johns Hopkins Univ., Baltimore, MD, USA

**A Spectral Study of a New Class of Radio Quasars**

Perlman, Eric S.; April 1, 2003; 2 pp.; In English

Contract(s)/Grant(s): NAG5-9533; NAG5-9995; No Copyright; Avail: CASI; [A01](#), Hardcopy

This document serves as a final technical report for NASA grants NAG5-9995 and NAG5-9533, entitled 'A Spectral Study of a New Class of Radio Quasars.' The purpose of these grants were to support observations made using the BeppoSAX satellite. The observations took place over two years and covered two SAX observing cycles, respectively AO-3 and AO-4.

During this time, I was employed both at Johns Hopkins University (NAG5-9995) and the University of Maryland, Baltimore County (NAG5-9533). As the research on these grants was on the same subject and my employment at JHU and UMBC has been consecutive, this document therefore covers both grants. The targets for these observations were four radio-loud quasars chosen from the first two X-ray selected samples of such objects. These were the brightest examples of the newly found class of X-ray loud flat-spectrum radio quasars, which prior to 1997, had never been seen before. However, my previous work with collaborators Paolo Padovani and Paolo Giommi on the DXRBS survey showed that they make up about 25% of the population of flat-spectrum radio quasars, but had not been seen before because of selection biases (all previous samples of these objects had been compiled in the radio). The purpose of the SAX observations was to investigate the shape of their X-ray spectrum, which would tell us where the peak of their synchrotron emission was located.

Author

*Quasars; Synchrotron Radiation; X Rays; Targets*

**20030020814** Massachusetts Inst. of Tech., Cambridge, MA, USA

**A Study of the Non-Thermal X-Ray Emission of Shell-Type Supernova Remnants**

Allen, Glenn E.; March 20, 2003; 48 pp.; In English

Contract(s)/Grant(s): NAG5-9237; No Copyright; Avail: CASI; [A03](#), Hardcopy

We present an analysis of the X-ray spectrum of the Galactic shell-type SNR G347.3-0.5 (RX 51713.7-3946). This SNR is a member of a growing class of SNRs which are dynamically young, shell-type sources that emit non-thermal X-rays from specific regions on their outer shells. By performing a joint spectral analysis of data from observations made of G347.3-0.5 using the ROSAT PSPC, the ASCA GIS and the RXTE PCA, we have fit the spectra of particular regions of this SNR (including the bright northwestern and southwestern rims, the northeast rim and the interior diffuse emission) over the approximate energy range of 0.5 through 30 keV. We find that fits to the spectra of this SNR over this energy range using the SRCUT model were superior to a simple power law model or the SRESC model. We find that the inclusion of a thermal model with the SRCUT model helps to improve the fit to the observed X-ray spectrum: this represents the first detection of thermal X-ray emission from G347.3-0.5. Thermal emission appears to be more clearly associated with the diffuse emission in the interior of the SNR than with the bright X-ray emitting rims. A weak emission feature seen near 6.4 keV in the RXTE PCA spectrum most likely originates from diffuse X-ray emission from the surrounding Galactic Ridge rather than from G347.3-0.5 itself. We have analyzed our RXTE PCA data to search for pulsations from a recently discovered radio pulsar (PSR 51713-3949) which may be associated with G347.3-0.5, and we do not detect any X-ray pulsations at the measured radio period of 392 ms. Using the best-fit parameters obtained from the SRCUT model, we estimate the maximum energy of cosmic-ray electrons accelerated by the rims of G347.3-0.5 to be 19-25 TeV (assuming a magnetic field strength of  $B = 10\mu\text{G}$ ), consistent with the results of Ellison et al. We present a broadband (radio to gamma ray) photon energy-flux spectrum for the northwestern rim of G347.3-0.5, where we have fit the spectrum using a more sophisticated synchrotron-inverse Compton model with a variable magnetic field strength. Our fit derived from this model yields a maximum energy of only 8.8 (+4.1) (-3.4) TeV for the accelerated cosmic-ray electrons and a much greater magnetic field strength of 150 (+250) (-80). Finally, we compare the gross properties of G347.3-0.5 with other SNRs known to possess X-ray spectra dominated by non-thermal emission.

Author

*X Ray Spectra; Spectrum Analysis; Supernova Remnants; X Ray Astronomy*

**20030020827** Johns Hopkins Univ., Baltimore, MD, USA

**Participation In The AXAF Program As Interdisciplinary Scientist**

Giacconi, Riccardo; Norman, Colin A.; [2000]; 3 pp.; In English

Contract(s)/Grant(s): NAG8-1133; No Copyright; Avail: CASI; [A01](#), Hardcopy

We have supported the Advanced X-ray Astrophysics Facility (AXAF) project through specific studies and research in X-ray astronomy. Our research in X-ray astronomy has been concentrated in three projects: the ROSAT Deep Survey, the ROSAT All-sky Cluster Survey, and the study of moderate to high redshift clusters discovered serendipitously in long ROSAT pointings utilizing the wavelet transform. We have continued to develop the techniques and catalogues described in the publications listed below. The PI continued to participate in the SWG and attended its meetings except where conflicts existed. The Co-I supported the PI and attended all meetings in order to provide continuity. A post-doctoral fellow (Rosati) was hired to fully develop the techniques described above and make them applicable to the AXAF program. The results are described in the publications below. We continued to provide analysis of scientific and technical issues to the project scientist as appropriate. We made detailed simulations of the AXAF deep survey program and have made this available to the project and



the ASC. The principal scientific results, discussed in great detail in the publications listed below, are as follows: (1) The wavelet transform is now a fine working tool for the analysis of faint X-ray sources especially clusters. (2) The analysis of the ROSAT DEEP CLUSTER SURVEY has given important constraints on cosmology particularly on the matter content of the universe and the amplitude of the fluctuations that created the galaxies and clusters. (3) The ROSAT DEEP SURVEY in the Lockman Hole has given an important deep survey in the X-ray band that gives vital data on the distribution and evolution of X-ray sources. It is an important and complementary data base to compare with the AXAF deep fields. (4) The Northern ROSAT All Sky Cluster Survey now has a complete catalog and is again important and complementary to AXAF/ Chandra studies of clusters which are deeper but in a narrower area. These projects have had a significant impact on the whole field and have set up some excellent experiments to be undertaken with the AXAF/Chandra telescope such as the Chandra Deep Field South.

Author

*X Ray Astronomy; X Ray Astrophysics Facility; Wavelet Analysis; Red Shift; Data Bases*

**20030020832** Hawaii Univ., HI, USA

**A Survey of Massive Planets by Direct Imaging with Advanced Adaptive Optics**

Owen, Tobias C.; [2003]; 2 pp.; In English

Contract(s)/Grant(s): NAG5-8298; No Copyright; Avail: CASI; [A01](#), Hardcopy

The observations are completed. The observing that has been done essentially on the Canada-France-Hawaii Telescope with the PUEO adaptive optics system, is sufficient to identify approximately 10 Jupiter masses objects around the selected targets. A small amount of data was also collected on the Gemini Telescope with the Hokupa'a adaptive optics system. For most of the stars of the sample, about 30mn of exposure time was collected per epoch, with at least 2 epochs. About 15% of the stars of the sample did not meet these requirements, due to observing difficulties listed below: (1) Guide star is too faint for the AO system; (2) The guide star is a close double (about 0.5 to 1 inch separation), which makes it unsuitable for AO guiding; (3) For a few stars, weather and observing constraints could not allow observations.

Author

*Gas Giant Planets; Extrasolar Planets; Planet Detection; Adaptive Optics; Data Reduction*

**20030020834** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Particle Acceleration in SN1006 Shock Waves**

Raymond, John C.; Ghavamian, Parviz; Sonneborn, George, Technical Monitor; March 2003; 2 pp.; In English

Contract(s)/Grant(s): NAG5-10352; No Copyright; Avail: CASI; [A01](#), Hardcopy

This grant is for the analysis of FUSE observations of particle acceleration in supernova remnant SN1006 shock waves. We have performed quick look analysis of the data, but because the source is faint and because the O VI emission lines on SN1006 are extremely broad, extreme care is needed for background subtraction and profile fitting. Moreover, the bulk of the analysis in will consist of model calculations. The Ly beta and O VI lines are clearly detected at the position in the NW filament of SN1006, but not in the NE position where non-thermal X-rays are strong. The lack of O VI emission in the NE places an upper limit on the pre-shock density there.

Author

*Far Uv Spectroscopic Explorer; Particle Acceleration; Shock Waves; Supernova Remnants; Emission Spectra; X Ray Astronomy*

**20030020848** Smithsonian Astrophysical Observatory, Cambridge, MA, USA

**Molecular Hydrogen in the Quiescent Disk of SW UMA**

Raymond, John C.; Menou, Kristen; Sonneborn, George, Technical Monitor; March 2003; 2 pp.; In English

Contract(s)/Grant(s): NAG5-10353; No Copyright; Avail: CASI; [A01](#), Hardcopy

The data have been acquired and re-reduced by Alex Lobel. We do not detect the molecular hydrogen transitions expected from models of a molecular disk illuminated by Ly alpha photons. We are currently working on an interpretation of the O VI emission lines to determine whether they arise in the disk or the boundary layer. The upper limit on continuum flux will provide an important constraint on models of white dwarf heating in cataclysmic variables.

Author

*Hydrogen; Molecular Gases; Data Processing; Emission Spectra; Electron Spectroscopy*

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

**20030020632** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**Groups and the Entropy Floor: XMM-Newton Observations of Two Groups**

Mushotzky, R. F.; Figueroa-Feliciano, E.; Loewenstein, M.; Snowden, S. L.; 2002; 24 pp.; In English; No Copyright; Avail: CASI; [A03](#), Hardcopy

Using XMM-Newton spatially resolved X-ray imaging spectroscopy we obtain the temperature, density, entropy, gas mass, and total mass profiles for two groups of galaxies out to approximately  $0.3 R(\text{sub vir})$  ( $R(\text{sub vir})$ , the virial radius). Our density profiles agree well with those derived previously, and the temperature data are broadly consistent with previous results but are considerably more precise. Both of these groups are at the mass scale of  $2 \times 10^{13} M(\text{solar mass})$ , but have rather different properties. Both have considerably lower gas mass fractions at  $r < 0.3 R(\text{sub vir})$ , than the rich clusters. NGC2563, one of the least luminous groups for its X-ray temperature, has a very low gas mass fraction of approximately 0.004 inside  $0.1 R(\text{sub vir})$ , which increases with radius. NGC4325, one of the most luminous groups at the same average temperature, has a higher gas mass fraction of 0.02. The entropy profiles and the absolute values of the entropy as a function of virial radius also differ, with NGC4325 having a value of approximately  $100 \text{ keV cm}(\text{exp } -2)$  and NGC2563 a value of approximately  $300 \text{ keV cm}(\text{exp } -2)$  at  $r$  approximately  $0.1 R(\text{sub vir})$ . For both groups the profiles rise monotonically with radius and there is no sign of an entropy 'floor'. These results are inconsistent with pre-heating scenarios that have been developed to explain a possible entropy floor in groups, but are broadly consistent with models of structure formation that include the effects of heating and/or the cooling of the gas. The total entropy in these systems provides a strong constraint on all models of galaxy and group formation, and on the poorly defined feedback process that controls the transformation of gas into stars and thus the formation of structure in the universe.

Author

*Galactic Evolution; Cooling Flows (Astrophysics); Interstellar Gas; Entropy; Astronomical Models; X Ray Spectroscopy; Galactic Structure*

**20030020696** Universities Space Research Association, Greenbelt, MD, USA

**Improved Bounds on Violation of the Strong Equivalence Principle**

Arzoumanian, Z.; [2002]; 6 pp.; In English; No Copyright; Avail: CASI; [A02](#), Hardcopy

I describe a unique, 20-year-long timing program for the binary pulsar B0655+64, the stalwart control experiment for measurements of gravitational radiation damping in relativistic neutron-star binaries. Observed limits on evolution of the B0655+64 orbit provide new bounds on the existence of dipolar gravitational radiation, and hence on violation of the Strong Equivalence Principle.

Author

*Pulsars; Binary Stars; Gravitational Waves; Gravitational Binding Energy; Stellar Physics; Relativistic Theory; Orbit Decay*

**20030020718** NASA Goddard Space Flight Center, Greenbelt, MD, USA

**The Spectral Results of the FIRAS Instrument on COBE**

Fixsen, Dale J.; Mather, John C.; [2002]; 10 pp.; In English; Copyright; Avail: CASI; [A02](#), Hardcopy

The Cosmic Microwave Background (CMB) spectral results of the FIRAS instrument are summarized. Some questions that have been raised about the calibration accuracy are also addressed. Finally we comment on the potential for major improvements with new measurement approaches. The measurement of the deviation of the CMB spectrum from a 2.725 plus or minus 0.001 K blackbody form made by the COBE-FIRAS could be improved by two orders of magnitude.

Author

*Cosmic Background Explorer Satellite; Spectrum Analysis; Far Infrared Radiation; Spectrophotometers; Microwave Radiometers; Satellite Instruments*

**20030020793** Alabama Univ., Huntsville, AL, USA

**Studies of Accreting Neutron Stars with RXTE Cycle 4 Observations: II: Too Observations of Transient LMXBs**

Pacinas, William S.; December 11, 2002; 2 pp.; In English

Contract(s)/Grant(s): NAG5-9045; No Copyright; Avail: CASI; [A01](#), Hardcopy

NASA Grant NAG 5-9045 provided funds for the research project ‘TOO Observations of Transient LMxBs’ approved under the Rossi X-ray Timing Explorer (RXTE) Guest Observer Program Cycle 4 and funded under the 1999 NASA Astrophysics Data Program. The principal investigator of the observing time proposal was Dr. M. Mendez (U. of Amsterdam). The grant was funded for one year beginning 3/1/2000. The original proposal was submitted by Prof. Jan van Paradijs, who passed away in 1999 before the funds were distributed. Prof. William S. Pauesas administered the grant during the period of performance. In spite of a wealth of observational data on the kHz QPO in low-mass X-ray binaries (LMXBs), the interpretation of this phenomenon is currently uncertain because the pairs of kHz QPO peaks and the oscillations seen in some Type I X-ray bursts are almost, but not quite, connected by a simple beat frequency relation. The proposal was intended to contribute to a solution to this confusion by making RXTE target-of-opportunity observations of two transient LMXBs, Aql X-1 and 4U 1608-52, if the sources became sufficiently bright.

Author

*Neutron Stars; Deposition; X Ray Timing Explorer; Accretion Disks; Mass*

**20030020804** Submillimeter Observatory, Hilo, HI, USA

#### **The Measurement of the Magnetic Field in Molecular Clouds**

Houde, Martin; Bastien, Pierre; Dotson, Jessie L.; Dowell, C. Darren; Hildebrand, Roger H.; Peng, Ruisheng; Phillips, Thomas G.; Vaillancourt, John E.; Yoshida, Hiroshige; [2002]; 7 pp.; In English; Chemistry as a Diagnostic of Star Formation, 21-23 Aug. 2002, Canada

Contract(s)/Grant(s): NSF AST-99-80846; NSF AST-99-87441; NSF AST-02-04886

Report No.(s): Rept-2002-7; Copyright; Avail: CASI; [A02](#), Hardcopy

We discuss how the combination of Zeeman, polarimetry and ion-to-neutral molecular line width ratio measurements permits the determination of the magnitude and orientation of the magnetic field in the weakly ionized parts of molecular clouds. Zeeman measurements provide the strength of the magnetic field along the line of sight, polarimetry measurements give the field orientation in the plane of the sky and the ion-to-neutral molecular line width ratio determines the angle between the magnetic field and the line of sight. We show the first results obtained with this technique on the M17 star-forming region using a HERTZ 350 pm polarimetry map and HCO(+)-to-HCN molecular line width ratios to provide the first view of the spatial orientation of the magnetic field in M17.

Author

*Molecular Clouds; Ionized Gases; Polarimetry; Zeeman Effect; Magnetic Measurement; Spectral Line Width; Magnetic Flux; Magnetic Clouds*

**20030020828** Alabama Univ., Huntsville, AL, USA

#### **Studies of Accreting Neutron Stars with RXTE Cycle 4 Observations: III: TOO Observations of Atoll Sources**

Paciesas, William S.; December 11, 2002; 2 pp.; In English

Contract(s)/Grant(s): NAG5-9244; No Copyright; Avail: CASI; [A01](#), Hardcopy

NASA Grant NAG 5-9244 provided funds for the research projects ‘ASM-Triggered TOO Observations of Kilohertz Oscillations in Five Atoll Sources’ and ‘Further Measurements of the Kilohertz Oscillations in 4U 1705-44’ approved under the Rossi X-ray Timing Explorer (RXTE) Guest Observer Program Cycle 4 and funded under the 1999 NASA Astrophysics Data Program. The principal investigator of the observing time proposals was Dr. E. C. Ford (U. of Amsterdam). The grant was funded for one year beginning 3/15/2000. The original ADP proposal was submitted by Prof. Jan van Paradijs, who passed away in 1999 before the funds were distributed. Prof. William S. Padesas administered the grant during the period of performance. In spite of a wealth of observational data on the kHz QPO in low-mass X-ray binaries (LMXBs), the interpretation of this phenomenon is currently uncertain because the pairs of kHz QPO peaks and the oscillations seen in some Type I X-ray bursts are almost, but not quite, connected by a simple beat frequency relation. Further systematic studies of systems with known QPOs are required in order to better understand the phenomenon. The proposals were intended to contribute to a solution to this confusion by observing the sources as they vary over a wide range of X-ray flux. RXTE target-of-opportunity observations of six transient atoll sources, 4U 0614+09, KS 1732-260, Ser X-1, 4U 1702-42, 4U 1820-30 and 4U 1705-44 were to be performed at various flux levels based on ASM measurements.

Author

*Neutron Stars; Accretion Disks; X Ray Timing Explorer; Stellar Oscillations; X Ray Binaries; Data Processing*

**20030020838** Space Telescope Science Inst., Baltimore, MD, USA

**Planet Forming Protostellar Disks**

Lubow, Stephen; [2002]; 4 pp.; In English

Contract(s)/Grant(s): NAG5-4310; STScI Proj. J0542; No Copyright; Avail: CASI; [A01](#), Hardcopy

The proposal achieved many of its objectives. The main area of investigation was the interaction of young planets with surrounding protostellar disks. The topics of interest include: 1) Simulations of Planet-Disk Interactions; 2) Secular Interactions Between Inclined Planets and a Gaseous Disk; 3) On the Tilting of Protostellar Disks by Resonant Tidal Effects; 4) Three-Dimensional Waves in Thermally Stratified Disks; and 5) Predictions of the Distribution of Planets. A list of publications resulting from this grant is also presented.

CASI

*Accretion Disks; Protostars; Extrasolar Planets; Star Formation; Circular Orbits*

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**LUNAR AND PLANETARY SCIENCE AND EXPLORATION**

Includes planetology; selenology; meteorites; comets; and manned and unmanned planetary and lunar flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance*.

**20030020724** Massachusetts Inst. of Tech., Cambridge, MA, USA

**Physical Characterization of the Near-Earth Object Population**

Binzel, Richard P.; March 24, 2003; 3 pp.; In English

Contract(s)/Grant(s): NAG5-12355; No Copyright; Avail: CASI; [A01](#), Hardcopy

This program seeks to address the fundamental question: What are the relationships between asteroids, comets, and meteorites? To answer this question, we are studying the population of asteroids near the Earth which likely contain both asteroids and extinct comets and which is the immediate source for meteorites. An analysis of new and existing visible wavelength spectral data for more than 100 (Near-Earth Objects) NEOs, and Keck albedo data for more than 20 NEOs is underway. New asteroid-meteorite links are being found, the NEO population and hazard is being characterized, and the extinct comet component is being constrained. These results are contained within the following publication work during the current period: 1 book, 2 book chapters, 1 published paper, 2 papers submitted, 2 papers in preparation, 1 Ph. D. thesis in preparation, and 7 meeting abstracts/presentations.

Author

*Meteorites; Asteroids; Comets; Near Earth Objects; Asteroid Detection; Meteorite Parent Bodies*

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